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DEVELOPMENT OF COLONIAL DEPENDENCIES

THE report on the operation of the Colonial Development and Welfare Act, 1940, to October 31, 1942, and, more especially, Sir Frank Stockdale's report on Development and Welfare in the West Indies, 1940–1942, give a very clear picture of the ideas which are inspiring Great Britain in the discharge of its responsibilities to its Colonial dependencies at the present time. There can be no question that the future of the world depends largely on the ability of Britain and the United States to understand one another and to work together, and questions of Colonial policy must inevitably involve a searching test of that capacity for co-operation. It would be most unfortunate if Colonel Oliver Stanley's speech at Oxford on March 5, with its firm rejection of international administration of the Colonies, were misinterpreted as implying the denial of the rights of third parties to take an interest in the Colonial policy of the Colonial Powers.

Colonel Stanley appears to share the new conception of social and economic purpose to which Prof. W. K. Hancock directs attention in his "Survey of British Commonwealth Affairs", and which forms the theme of some striking sections in Lord Hailey's recent booklet, "Britain and her Dependencies". The conception of the welfare of nations, as Prof. Hancock truly says, brings hope. "It offers a new stimulus to take the place of the moving frontiers; it promises to an expansionist society the means of living in harmony with its own nature, even in an age when geographical expansion has reached its limits. A struggle to raise the standard of the depressed classes and the depressed areas of the world could have a dynamic effect comparable with the discovery of a new America."

This is the new conception into which the new programme of Colonial development and welfare naturally fits, and in his close analysis, first of the evolution of the settlers' frontier in Southern Africa, and then of the traders' frontier in West Africa, Prof. Hancock shows how large a place must be taken by scientific research and inquiry, the incompleteness of slogans and programmes and the necessity for a new attitude and new methods, above all for the formulation and pursuit of a clear policy in place of hesitation and pusillanimity. Sir Frank Stockdale's report is in striking harmony with Prof. Hancock's observations on West Africa. The problem of the West Indies is at bottom one of poverty, aggravated by movements in world economy which have heavily damaged their trade, and the guiding principle of Sir Frank Stockdale's administration of the West Indian Welfare Fund is the stimulation of capacity to earn an income, not merely the provision of income. In regard to health matters, special attention has been given to the development of health units and to the control of malaria, which constitutes a serious economic problem in some areas, yaws and venereal diseases. The approved scheme for Jamaica, for example, provides for improving and extending the

existing procedure for malaria control; establishing a research unit to investigate malaria and mosquito problems not only in Jamaica but also in British Honduras, the Turks and Caicos Islands and the Cayman Islands; and experiments and demonstrations in malaria control and land benefaction and for testing new methods, by the Medical Department and research unit in collaboration. Greater attention is being given to sanitation and to improved diet, as well as to better housing conditions and improved water supplies, which are required to improve health conditions.

In regard to agriculture, the Comptroller is devoting considerable attention to soil erosion, which presents a constant danger of irremediable impoverishment to many of the islands. A further objective has been the development of mixed farming systems to maintain or improve soil fertility and to increase the consumption of milk, the present most urgent nutritional need of the people, simultaneously displacing the dependence on imported tinned luxuries. Nutrition, in fact, has taken a high place in the planning of agricultural schemes, and in regard to land settlement the necessity of a more fundamental approach is stressed.

The report repeatedly emphasizes the importance of research, and while the proposals, which can only be implemented after the War, are not complete, the centralization of fundamental and long-term research in association with the Imperial College of Tropical Agriculture, Trinidad, is regarded as vital to the future needs of agriculture in every part of the West Indies. The proposals provide for research in plant-breeding for the major economic plants and food crops; for soil surveys of all the potential agricultural areas of the West Indies which have not yet been adequately surveyed, as well as soil-conservation studies. Provision for the development of animal husbandry and the breeding of efficient breeds of cattle, small stock and poultry which can stand up to the West Indian climate is also proposed, as well as entomological investigations, particularly in regard to foodstuffs. Grants have been approved for schemes for low-temperature investigations on the storage of fruit, vegetable and animal products, and for fisheries investigations; the Sugar Manufacturers Association will maintain its own research organization during the War, and proposals for sugar technology and research into new uses for the sugar-cane and its by-products are deferred.

Concentration of all these lines of research in Trinidad is neither practicable nor desirable, although Jamaica is the proposed site for the central research stations for animal breeding and for the breeding of bananas immune to Panama and Cercospora disease. There is no intention of moving the West Indian Sugar-Cane Breeding Station from Barbados. A scheme is in operation for investigation of the insect pests of food crops and problems of food storage in the Windward and Leeward Islands; and in connexion with endeavours to divert a proper proportion of effort from an export trade in sugar it is noted that in Trinidad the ruin of large areas of cocoa by witchbroom disease has rendered the sugar-cane the only immediate alternative cash-crop, and that derris is a promising alternative crop for the large sugar estates of Trinidad and Jamaica.

Although Trinidad now derives most wealth from its mineral oil resources, the majority of the population is dependent on agriculture, and the economic position of the producer of agricultural exports in Trinidad is probably the most difficult of the West Indies. The local Government has therefore appointed a committee to formulate a long-term policy for agriculture in the Colony, to lay down the broad lines for research, and, in general, to submit comprehensive proposals for the betterment of agriculture. The report of this committee is not expected before the end of the year. Detailed investigations on the sea fisheries of Barbados, Trinidad and British Guiana are in progress, and in this field there is special reference to co-operation with the United States Fish and Wildlife Service (Department of the Interior), and further co-operation has been promised by the United States authorities in a development scheme for commercial fishery research and to institute food-fish production projects.

A stimulating section of the report on social welfare pays tribute to the constructive work of Jamaica Welfare Limited, and provision for similar work with grant aid under the Colonial Development and Welfare Act has been recommended for certain other Colonies. The feature of this section is its lucid discussion of first principles, objectives and methods. The economic future of the West Indies rests with agriculture, and both in welfare work and education Sir Frank Stockdale is concerned to check the marked and dangerous drift from the country to the towns. The primary problem is how to enable the people to live on the land to their own satisfaction, and a particularly intimate relation between the agricultural and social welfare services is thus required. Weaknesses in social structure have convinced the agricultural experts of the importance of welfare work, just as the weaknesses in economic structure have convinced the social administrator of the need for better agriculture.

A social welfare programme for the West Indies must provide for three requirements: first, the co-ordination of all existing public and voluntary social services in the promotion of the welfare of the people of each Colony; secondly, the active encouragement of changes in social institutions and habits when this is desirable; and thirdly, the more effective administration of those social services which are apt to be neglected at present because they cannot be fitted into the responsibilities of any of the more important Government Departments. The most obvious gap in the apparatus of social administration in the West Indies is machinery for research. Without it, objective information about social conditions cannot be obtained and a secure basis for social policy is lacking. A few social surveys of the type familiar in Great Britain would encourage dispassionate thinking and objective fact-finding about social problems, as well as make it easier to introduce modern techniques of accurate measurement of size and intensity, and to promote clarity and coherence in social policy.

Research is also a necessary aid to the training of social workers and in education, where considerable modifications in the system will be required if it is to fulfil the requirements; the crux of reconstruction is the training of the teacher, especially in outlook. While the administration of the Fund is already looking ahead to the encouragement of higher education and the training of teachers, it recognizes as the first real need the reform of the existing system of education, the improvement of buildings and staff and a modernization of the teaching to provide the foundations of an education which will fit the children for wider community interests and activities when they grow up. Sir Frank Stockdale believes in training the young for the kind of life they will naturally live in their own economic environment.

Lord Hailey's booklet, however, shows that much remains to be done. The first charge on the resources provided by the Colonial Development and Welfare Act should, in his opinion, be improvement of conditions of subsistence and production, and development of the simpler secondary industries. The growth of agrarian indebtedness is an evil which must be checked if it is not to become as grave an economic menace as in India, Burma and Egypt. There is need for firm and comprehensive treatment. Again, he suggests that in view of the insufficient revenues of the social services, the local administrations should take a sufficient share of the profits of foreign enterprise. The whole question of the taxation of undertakings operating in the dependencies must clearly, as he proposes, be re-examined after the War. These economic questions lie in the very forefront of discussions on the practical steps which should be taken to achieve the economic objectives of the Atlantic Charter, to which Great Britain is committed.

The place of the Colonial dependencies in such a world political association as Mr. Morrison recently sketched is obvious, and Great Britain is moving in the right direction, as these reports have shown. Moreover, Mr. Morrison's speeches, notably that at Newcastle on January 10, have done much to stimulate interest and clarify thought on the positive aspects of Colonial policy, and to prepare public opinion for that larger expenditure which is undoubtedly called for if these objectives are to be realized.

It should be remembered, moreover, that though economic questions bulk large and our constructive social and economic policies have, as Mr. Morrison observed, not matched the political enlightenment and humane integrity of our Colonial administration, there are fresh political and administrative issues that have to be faced. Regional schemes and grouping are already here, and their implications must be explored. We must recognize that Colonial partnership cannot attain full fruition within the framework of the British Commonwealth alone, and whereas international administration or responsibility may be rejected, the problem of working out new methods of international co-operation in research, supervision and control remains. Again, we must at least face the question whether the dependencies could be assured of the substance of self-government by some method other than that we are now pursuing. Such a study might show that there is after all no alternative; but it would be regrettable, to say the least, if we found ourselves in difficult country at the end of the journey, should we also have cause to reflect that we had not even considered the direction in which our path was leading us.

It is such reasons as these which give pertinence to the discussions on the Colonial Service and its reform, and to the proposals for a Colonial Development Board, in recent Parliamentary debates and in the booklet "Downing Street and the Colonies" recently issued by the Fabian Society*. The adequacy of the machinery of government by which effect is to be given to the new policies must come under review, and although the idea of a Colonial Development Board has been rejected by the Government, that of an advisory board has again been urged by Squadron-Leader P. Donner, and the proposal for a standing parliamentary committee on Colonial affairs is too valuable a means of increasing interest and educating Parliament itself in Colonial affairs to be lightly rejected. The greater provision for Colonial studies in the leading universities of the British Empire, as urged by Prof. Daryll Forde, Dr. Julian Huxley and Miss Margaret Perham, would be a further factor in the education of public opinion, and in teaching and training members of the Colonial service, as well as in co-operation between the Colonial Office and Colonial Governments in carrying out the long-range research so urgently needed in such problems as Colonial law and land tenure, the relation between local government based on tribal traditions and the European forms of central and municipal government.

Much is being done by the Government already to meet the requirements of the situation, and even Colonel Stanley's review did not cover the whole field; he was unable, for example, to refer to the work of the new executive body, the Colonial Products Research Council, of which Lord Hankey is chairman, and which is destined both to promote the welfare and prosperity of Colonial peoples and the Colonial contribution to the welfare and prosperity of the British Empire and of the world as a whole. The very fact that the welfare of the Colonial empire is so closely linked with that of the world and that their long-term interests are the same makes it imperative that the task of educating, not only the people of Great Britain, its dependencies and the Dominions, but also the United Nations, as to the British achievements—of which we have a right to be proud, in spite of all shortcomings—should be undertaken with energy and imagination as a part of the task of building the peace. If the British contribution to world order, that great factor of stability and progress to which Mr. Morrison referred, is to be made active, steps must be taken to remove the misconceptions of the British Commonwealth which our enemies are only too sedulous in fostering. That is a task in which every good citizen can and should

* Downing Street and the Colonies. Report by the Fabian Colonial Bureau. Pp. 100 (London: George Allen and Unwin, Ltd., 1943.) 2s. net.

play his part; for without it the definite action and discussions before Governments to secure concrete agreement on the machinery by which effect is to be given to post-war collaboration between the United Nations as well as on the practical policy to be pursued cannot be assured of the full support upon which their fulfilment depends. Intensive study is necessary to find a basis upon which durable Anglo-American co-operation is possible, and to devise a common approach and common action in world problems which neither democracy alone can solve. Visits such as that which Mr. Anthony Eden has recently undertaken can be of inestimable value in this way.

CHEMICAL BACKGROUND OF GROWTH

Biochemistry and Morphogenesis

By Joseph Needham. Pp. xvi+785+36 plates. (Cambridge: At the University Press, 1942.) 52*s.* 6*d.* net.

"BIOCHEMISTRY AND MORPHOGENESIS" consists of six hundred and seventy-seven pages each of about five hundred and fifty words. To these are appended (1) a glossary of eight pages, (2) one page on which are listed "Terms and concepts the use of which is not recommended", (3) a bibliography of seventy-six pages, a general index, an index of animals, and (4) an index of plants and an index of genes. The book, however, lacks an index of authors giving the page in the book on which the name of any author occurs. It follows that for every nine pages of matter there is one page of references. This fact alone attests the encyclopædic nature of the work. The book is obviously a very unusual one, and it may be said at once that no one who seriously concerns himself with the chemical aspect of development can afford to be without it.

The title is calculated to whet the curiosity of the reader, because it contains no implication of what the relationship between the two substantives linked by the word "and" may be; neither in the title dominates the other. The reader opens the book then with the expectation and hope of being informed upon the precise relationship between morphogenesis and biochemistry.

Dr. Needham sets out his own view of the plan of the book in the following words. "A discussion such as the following may be modestly compared to one of those narrow-gauge railway lines joining distant places, in which some European countries abound. Sometimes it runs along the well polished tracks of trunk communications, sometimes it strikes across country, winding through pastoral or wooded valleys with more originality; at one point it touches some obscure village, at another it pauses for a moment to make a junction with a main road. In the present state of our knowledge this is all that biochemistry can contribute. . . . The chemin-de-fer vicinal must not be mistaken for the routes of the great expresses." The routes of the great express (or is it the expresses themselves?) are other books: Hans Spemann's Silliman Lectures, Huxley and de Beer, the monograph of Daleq and so forth. The reader therefore visualizes Needham's work as a line piloting the train of biochemistry across these various tracks of morphogenesis. What the biochemist can say about each and about a number of lesser but interesting matters is said, and the *chemin-de-fer vicinal* even has some branches of its own. The light railway 'motif' applies not only to the matter in, but also to the format of, the book. It is not divided in chapters, it just runs. Each paragraph is numbered and the arrangement of the material is indicated by the numbering. Take, for example, paragraph 2·335. The 'two' indicates that the paragraph has to do with "morphogenic stimuli"; the 'three' in the first decimal place, that as a subdivision of 'two', the paragraph deals with amphibian development and general principles; the second 'three' as a sub-subdivision, that it is concerned with the vertebrate axis; and lastly the 'five' that as a sub-sub-subdivision it deals with the endoderm and mesoderm. All this you find in the 'contents' at the commencement of this book. I can imagine this method as being very helpful when the reader has accustomed himself to it, especially when the book is used for reference. The method will be new to most readers of biology and has, I believe, been taken over from mathematical works in which it found early exponents in Whitehead and Russell.

Turning from the manner to the matter, the first ninety pages deal with what the author calls the "morphogenetic substratum". This part concerns itself with such subjects as the constitution of the ovum, the egg and its environment, embryonic nutrition, the placenta and so forth. Being rather of the nature of a prelude, it is a descriptive account of the egg and its nourishment over the range of animal life, written from the chemical point of view; but it is much more than a mere compilation, for the author has worked over much of the data which he cites and presents in a way which emphasizes his own interpretation of it. To take an example, anyone wishing to look up what is known about the passage of substance across the placental barrier will find all the references in Needham's book, together with his own view—that the placenta is a rather complicated ultra-filter—a view which not everyone will accept.

My guess is that the real interest of the author commences to reveal itself on p. 98, when he passes from a discussion of the milieu of his subject to the subject itself.

Pp. 98–175 (§ 2·05–2·34) contain an informing description of the general principles of development at the early stages: induction competence, regional development, gastrulation, the primary organizer and so forth, but they contain approximately no biochemistry. In the pages between 176 and 188, the reader gets to something more specific from the chemical point of view, namely, a description of the experiments of Needham himself and others on the induction of neural tubes in gastrulæ by the injection of definite chemical materials. The train is arrived at a station.

At paragraph 2·351 it drifts off again into the country. The author embarks on a discussion of the metabolism of the gastrula and pulls up at an important paragraph (2·353) on the role of sulphydryl in gastrular metabolism, followed by (2·355, there is no 2·354) one on the nature of inactive evocator complex, in which protein complexes with polysaccharides, lipins, of polysaccharides with lipines and so forth are discussed. At this point therefore such bodies as aneurin (vitamin B_1), flavo-protein (yellow enzyme), lactoflavin (vitamin B_2) co-carboxylase, and pyridoxin (vitamin B_6) come under survey. Perhaps the following paragraph may be quoted:

"We are thus coming to the general conception of combination with protein as the most important element in biological activity. An 'active' substance of low molecular weight will generally require combination with a specific protein in order that its activity may be manifested. It may be held in inactivated form on another, perhaps equally specific, protein. It may well be that the evocator has to be adsorbed on to a protein in order to carry out its effects, just as it has been previously liberated from an inactive combination. Unfortunately it is hard to picture exactly how the effect of the primary evocator is produced in competent cells. The problem will be referred to again in Section 3·5."

The discussion of organisms naturally leads to that of anomalies caused by their absence. Needham cites, for example, the effect of diets deficient in vitamin A causing blindness owing to the failure of the eye cups to develop. Thence the line leads to excess of organizers, to the consideration of twinning, terotomata and new growths.

The paragraphs under the general heading 2·38 (pp. 239–271) form perhaps the most arresting station on the railway. For this there are two reasons: first, the importance and scope of the subjects discussed; and secondly, the amount of definite biochemical knowledge which is applied to them. Here Needham links up sterols and bile acids with alkaloids, cardiac aglycones, anti-rachitic compounds, resin acids, saponin aglycones, adrenal cortex hormone, male sex hormones and androgens, female sex hormones and œstrogens, and these last with carcinogens and neurogens (primary evocator substances).

The sex hormones afford perhaps the outstanding instances of the production of definite changes in material form brought about by chemical bodies of established composition. To many readers the degrees of definiteness which the author can attain in his discussion of the physiologically, pathologically and pharmacologically active bodies built up in the sterol skeleton will be very welcome, and no one will grudge Dr. Needham the satisfaction with which, after discussing the constitution of vitamin D, he states, "It has been one of the triumphs of organic chemistry in recent years to show that other and more obscure substances of great biological activity also possess the sterol skeleton".

Ninety pages (pp. 340–430) are devoted to the relation between genetics and embryology, and these will be read with particular interest by many. The following sentence gives an idea of the drift of this part of the book: "It might even be said that the main difference between genetics and embryology is that in the former study only those inductors are described which are unable to pass through the cell-membranes of the cells in which they are formed, while in the latter, only inductors of more diffusible nature are described".

Of the four hundred pages which deal with stimuli, roughly 350 are concerned with vertebrate development; the last fifty chiefly with insects and echinoderms.

The final hundred or so pages of the text deal with respiration and metabolism. If I may be permitted to alter Dr. Needham's simile and regard the work as a railway of biochemistry traversing a population of morphogenesis, the railway started on p. 97 as a light one traversing a densely populated area; in the middle of the book it became a trunk line, still passing through a thickly populated district; towards the end it develops into a four-line track driving across fertile plains with but a cottage here and there. This part will be found extremely valuable to students of comparative physiology, but its claim to be connected with morphogenesis rests simply on the fact that life includes growth. There is very little about 'form'. The reader then will be informed about the respiration of the eggs of echinoderms, of worms, of molluscs, of arthropods, of fishes, of amphibia and of mammalian embryos. The important point is that the respiration of these forms is discussed in terms of recently acquired knowledge of respiratory pigments and respiratory enzymes.

Similarly with metabolism, Needham gives an excellent account of the subject in modern terms: the phosphorylation problem, protein metabolism in the higher and lower vertebrates and in the invertebrates, the growth-promoting factor, nuclein metabolism, lipin and sterol metabolism, pigment metabolism, pyrrol derivatives, lipochromes, flavines, pterines, melanin and many other topics. These discussions lead up to the organization of cell protoplasm.

The book leaves the reader with two definite impressions, namely, (1) the vast amount of work which has been carried out on the relation of development to the chemical processes responsible for it, and (2) how little of all this information is completely 'water tight'.

The following paragraph is typical of a great deal of the book.

"The active substances of the egg secretion have not so far been fully analysed. There is (1) the activator for the spawning male. This is believed to be glutathione or a similar sulphydryl compound in the case of polychætes (Townsend), but in molluscs its properties are different (Galtsov). There is (2) the activator for sperm motility. In echinoderms there seems to be a very volatile substance, since steam distillates of egg secretion are effective (Clowes and Bachman) as also propyl amyl, and cinnamyl alcohols. There is then (3) the substance responsible for the chemotactic attraction of spermatozoa (sometimes called aggregation); this has been identified by Hartmann, Schartau, Kühn and Wallenfels as the 978-pigment echinochrome, a polyhydroxy-naphthoquinone; though the claim is contested by Tyler. There is finally (4) the substance, or substances called 'fertilisin' by F. R. Lillie. This consists of two factors, the cleavage factor in the absence of which development cannot proceed, even if a sperm should penetrate the egg; and the agglutination factor which causes the spermatozoa to stick together around the egg-jelly".

The reader in time gets the impression that at times he is following a will o' the wisp, that he is hoping on the next page to find a direct and explicit statement that some important event in development is indubitably caused by some specific chemical compound of identifiable formula; too often he will discover that he has hoped in vain.

But Dr. Needham must not be held responsible for the state of knowledge of his subject, which is in the intermediate position between the simplicity of ignorance and that of complete understanding. He has performed a valiant task in marshalling the information which exists, a task which he has discharged conscientiously and skilfully. To him all interested in the subject at the level at which he treats it owe a debt of thanks for a welcome monograph.

J. BARCROFT.

PRECAUTIONS AGAINST CHEMICAL WARFARE

War Gases

Their Identification and Decontamination. By Dr. Morris B. Jacobs. Pp. xiii+180. (New York: Interscience Publishers, Inc.; London: Imperia Book Co., Ltd., 1942.) 3 dollars.

Gas Warfare

A Monograph for Instructors. Compiled by W. K. Fitch. Pp. 103. (London: Pharmaceutical Press, 1942.) 2s. 6d.

CHEMICAL weapons of war differ from other weapons in the degree to which it is possible for a well-prepared nation to protect itself against them. Probably the main reason why they have not yet been used in this War is that the Axis Powers know that our preparations for this form of warfare are very good. An important part of these preparations is the widespread dissemination of knowledge of the subject.

"War Gases", by Morris B. Jacobs, is an up-to-date review of the subject from the point of view of a chemist. It deals with all the important gases used in the War of 1914–18 and a few which were not. The physiological effect of each is briefly described, and estimates of its toxicity are quoted from various sources. In this section the concentrations are sometimes given as percentages, sometimes as parts per million and sometimes as milligrams per litre. It would be much easier to compare one gas with another, and one author with another, if concentrations were always given in milligrams per cubic metre. These units are small enough to avoid zeros following decimal points in most cases, and can be applied equally well to true gases, particulate smokes, and mixtures.

The main part of the book is devoted to details of the methods of taking samples of various materials without being poisoned, and of the methods of analysing them for war gases. The gas is placed in one of eight groups, or sub-groups, according to the presence or absence of hydrogen, sulphur, nitrogen, or arsenic, and tests for the individual compounds are then applied. The effects of war gases on materials of various kinds, and methods of decontamination, are discussed in some detail.

"Gas Warfare", by W. K. Fitch, covers a wider and more practical field. As editor of the *Pharmaceutical Journal*, the author is skilled in the presentation of data in a form which is likely to be attractive to those who have a scientific background, and as a member of the Home Guard he is supremely interested in practical applications. He has summarized the information published in the official handbooks and in larger text-books and presented it in a convenient and practical form. He discusses the history and properties of all the important gases, the weapons in which they are used, their detection and identification and questions of treatment and decontamination. He discusses the theory and detailed use of respirators, their efficiency and even the dermatitis which they may sometimes cause. He describes experiments on gas-proof rooms and methods of training, including the use of preparations which simulate the toxic materials without the danger. He devotes a chapter to the care of animals and gives a reasonably complete bibliography.

It is remarkable how much detailed information has been packed into this small book.

HISTORY OF SCIENCE

Studies in the History of Science

By E. A. Speiser, Otto E. Neugebauer, Hermann Ranke, Henry E. Sigerist, Richard H. Shryock, Evarts A. Graham, Edgar A. Singer, Hermann Weyl. (University of Pennsylvania: Bicentennial Conference.) Pp. v+123. (Philadelphia: University of Pennsylvania Press: London: Oxford University Press, 1941.) 9s. 6d. net.

THIS book consists of eight lectures on the history of science given at the bicentennial conference of the University of Pennsylvania. They are all of absorbing interest, although appealing severally to specialists and not to the general student.

The first lecture, dealing with Mesopotamia in the fourth millennium B.C., discusses the invention in ancient Sumer of what may be called writing. The records throw light on classificatory zoology, botany, geology and chemistry, and translations of them were made from Sumerian into Elamite, Hittite and other languages. The cylinder seal, the immediate ancestor of Mesopotamian writing, was, says Prof. E. A. Speiser, "first and foremost the Sumerian's mark of ownership". So the origin of writing was economic, and the result of a social order based on the recognition of personal rights. There is a marked contrast here with the civilization of Egypt, based on the supreme authority of the Pharaohs. The Egyptian script, perhaps borrowed from Mesopotamia, seems to present differences corresponding to the different cultures of these centres of civilization.

Prof. O. Neugebauer, in a lecture on fundamental concepts in ancient astronomy, discusses the determination of the hour as a unit of time and the way in which ancient astronomers dealt with the difficulty caused by the variable length of the day.

The next lecture has some interesting remarks about the two Egyptian medical papyri, the Ebers Papyrus and the Edwin Smith Papyrus. The former, a collection of recipes, was translated into English in 1937 by Dr. B. Ebbell, a Norwegian; the second, a surgical treatise, was published with translation and commentary by J. H. Breasted in 1930. The greater part of both is truly scientific, although here and there a piece of folk-medicine or superstition has been interpolated from far inferior sources.

Medieval medicine is discussed in an illuminating way by Prof. H. E. Sigerist. He shows how Arabs and Christians dealt with the problems raised by the adoption of an alien medical system that was only half understood, and finally achieved a medicine of their own by a process of assimilation and synthesis, followed by the revolt that accompanied the Renaissance.

The next two lectures, by Prof. R. H. Shryock and Prof. E. A. Graham respectively, deal with the birth of modern medicine and surgery during the last two hundred years. Medicine grew up with an increased attention paid to etiology rather than to syndromes; surgery depended upon attention to asepsis, anæsthetics and the avoidance of surgical shock. It is an old story, but the summaries here given are models of condensation, with many original observations scattered here and there.

The medical lectures are followed by Prof. E. A. Singer's exposition of what he calls a "logico-historical study of mechanism, vitalism, naturalism". When opposing schools of thought (for example, the mechanical view and the view that admits purpose in Nature) cannot settle their differences by experi-

mentation, Dr. Singer claims that an application of his method makes plain "what the essence of this conflict is; why it should have endured through so long a past; whether it need continue unresolved through all the future". His account is closely reasoned and cannot be summarized, but students of the history of thought will certainly profit by a close study of it.

The book concludes with a lecture on the mathematical way of thinking, written by Prof. Hermann Weyl. He defines it as "that form of reasoning through which mathematics penetrates into the sciences of the external world—physics, chemistry, biology, economics, etc., and even into our everyday thoughts about human affairs, and secondly that form of reasoning which the mathematician, left to himself, applies in his own field". It appeals "to the light in our innermost self". The interrelation between the sciences and mathematics goes back to Parmenides, at the very birth of Greek thought, and formed the essence of the Platonic philosophy. In those early days a solution was found by denying the reality of phenomena, but by this time we understand better the conditions of the problem, and make of mathematics a willing servant to help our thoughts, instead of allowing it to become a tyrannical master to check or suppress them. W. H. S. JONES.

AN ANTHROPOLOGIST LOOKS AT THE UNITED STATES

And Keep Your Powder Dry

An Anthropologist Looks at America. By Margaret Mead. Pp. x+274. (New York: William Morrow and Co., 1942.) 2.50 dollars.

IN this book an American looks at the United States. Her attitude is that the American authorities deserted the cause in 1919 and that the great slump of 1929–30 and its consequences were the retribution for their lack of moral courage. We may leave our American friends to argue that thesis, and deal here rather with the author's efforts to delineate American characteristics, which, as she rightly says, must be used in any constructive work for a better world.

The United States depended very largely on old skills brought by emigrants from Europe and on ideas even of machinery largely derived from Britain, but developed those machines enormously and achieved the revolution 'from the craftsman to the assembly line', with gain and loss to be set against one another. The book has a rather antique picture of Europe, feudal and peasant, and the England set forth is emphatically not the middle-class industrial north, nor is there any trace of Scottish porridge or tasty Welsh rarebit! But the people of the United States probably surpass the British people generally in their worship of success, a success which in American circumstances must be measured by money even more than it is among us. To the United States have streamed immigrants from rural Europe, learning to speak a little broken American and yearning to see their children take a larger part in the glittering, if not always brave, new world; and these children making their footing, absolve the next generation from using at home the old language from Europe as a sort of skeleton in the cupboard. The grandparents are a drag on the younger people, who want their children to go ahead again another step.

So it went on while the West was open-armed to receive men, and the 'dustbowl' was not yet filled with ruin. The question that presses itself on us all is how the United States will react now that there is so much less chance of geographical expansion. The author pleads for initiative and adventure in the realm of social relations, and her experiences of the peoples of the East Indies and the South Seas help her to an objective point of view that makes the book lively and interesting. Her Americans are not pugnacious but, in the words of the old song, "We don't want to fight, but, by Jingo, if we do . . .". Her Americans, again, come from many sources and traditions; and yet there is the possibility of orchestrating these many cultures into a symphony that must be American in its reliance on individual energy and initiative, in its plans that give directives rather than goals, in its tolerance that enriches life, even if sometimes it delays decisions.

H. J. FLEURE.

SPANISH ASTRONOMICAL DATA

Anuario del Observatorio Astronómico de Madrid para 1943

Pp. 236. (Madrid: Instituto Geográfico, 1942.)

THIS work is very similar to those for previous years, the chief alterations being a table for interpolating the heliographic longitude of the centre of the sun's disk, and also small modifications in the elements of the principal planets to bring them up to recent determinations. In "Efemérides Del Sol, Para 1943" and "Efemérides De La Luna, Para 1943", in addition to other information such as times of rising and setting at Madrid, meridian passage, sidereal time for 0h. at Greenwich, and the moon's horizontal parallax, right ascension and declination of the sun and moon for each day are given for the times of transit at Greenwich, pp. 42–53, 89–100. These latter correspond to those in pp. 22–29 and pp. 156–171 respectively in the "Nautical Almanac", but in the work under consideration co-ordinates are given only to the nearest second of time in right ascension and second of arc in declination. The equation of time is not included with the solar co-ordinates but is given in a separate table to the nearest minute for 0h. each day at Greenwich. Another table supplies the sun's semi-diameter for every 10 days, the distance from the earth to the sun in terms of an astronomical unit to four decimal places, and also the sun's diurnal orbital motion on each of the ten days.

Among other features may be mentioned the elements of the planets, a special part being devoted to those of Pluto. These have been revised since the 1942 issue of the volume, and the more accurate figures by Bower at Lick Observatory have been included. Ephemerides for the planets for every ten days are given and also elements for the physical observation of Mars and Jupiter at intervals of four and seven days respectively. Comet workers will find a useful compilation of the elements of thirty-four periodic comets on pp. 162–163, and lists of star clusters, nebulæ, variable stars, double stars, and of stars occulted by the moon, visible at Madrid, etc.

Full explanations with examples of the application of the tables, etc., are given, and even an amateur astronomer who has just started on the subject will find little difficulty in using the work. M. D.

VALUE OF MICRO-ORGANISMS IN NUTRITION (FOOD YEAST)

By Dr. A. C. THAYSEN

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THE extensive study of the biology and biochemistry of micro-organisms which has proceeded during the last two decades has greatly increased the appreciation of the important part which many micro-organisms play in the nutrition of man and animals.

During the nineteenth and early twentieth centuries the science of microbiology centred essentially around the pathogenic forms of microscopic life, and the demand for purity and sterility in foods of all descriptions became insistent and overriding; so much so, in fact, that even primitive communities who, like Europeans during the Middle Ages, had been accustomed to a daily intake of an appreciable quantity of micro-organisms, were relying largely on purified foods.

This change in dietetics is well illustrated by a reference to developments which have taken place in the brewing industry during the last century. To-day beer, with few exceptions, is supplied as a crystal-clear beverage from which all traces of yeast have been removed by filtration. During the Middle Ages beer, on the other hand, contained a large part of the yeast grown in it during brewing. When it is remembered that beer in those days was the most extensively consumed beverage, which was taken in considerable volume daily by all, even by quite young children, it will be appreciated that the consumption of yeast by the bulk of the population must have been very considerable indeed.

The same may be said to have been the case to an even greater and more significant extent in many tropical countries where freshly fermented and unfiltered, home-brewed beer or wine was drunk by the inhabitants in vast quantities during festive occasions until well-meaning but not equally well-instructed missionaries succeeded in banishing such beverages from the natives' diet. The effect on the health of the natives was bound to be profound, as will be appreciated when an outline has been given of the relevant biochemical properties of micro-organisms.

As is so often the case the work which led to an appreciation of the dietetic value of micro-organisms had its roots in an economic problem, the disposal of the surplus quantities of yeast which, year in year out, issued from the brewing plants of Europe and America. By the end of the nineteenth century chemical analyses had established that brewers' yeast contains a high percentage of protein. Attempts had also been made to utilize yeast as a protein concentrate in the feeding of cattle. Other suggested outlets for surplus yeast[1] (Klöcker, 1906) were as a substitute for coffee—a horrible thought—in soap manufacture and in the treatment of certain inflammatory conditions of man. However, though favourable reports on its value in such conditions were not lacking, and though equally favourable reports were from time to time given on its value as a protein concentrate in stockfeeding, little progress was made in the utilization of surplus brewers' yeast partly, no doubt, because of its bitter taste, due to its content of hop resins, and partly because its cost, as compared with that of other protein concentrates such as fish meal, was excessive. The disposal of surplus yeast remained an economic problem of some importance to the brewing industry.

When the War of 1914–18 broke out, Germany and her allies found themselves cut off from overseas sources of protein concentrates for stockfeeding, and attention was therefore again turned to the utilization of brewers' yeast. Furthermore, in anticipation of greatly increased demands for protein concentrates, investigations were started by the Central Powers to explore the possibility of applying the observations of Pasteur and Ducleaux and later of Märker[2], that protein can be synthesized by yeast from inorganic nitrogen, including ammonium salts. Delbrück and his collaborators had previously[3] worked out a method for the synthesis of protein from ammonium salts by growing yeast in worts containing sugars as the only organic food substance. But this method was uneconomic because of the low rate of synthesis secured.

By 1915 Hayduck[4] was able to report that he had succeeded in synthesizing protein from ammonia on a technical scale with much better yields than hitherto by using a type of yeast—presumably a species of Torula—which produced little alcohol and grew well in the absence of organic nitrogen. A yeast product of this type was put on the market in Germany at the time and recommended by its manufacturers as suitable for human consumption. However, large-scale production was apparently not proceeded with, probably owing to lack of sugars in Germany at the time. The digestibility of the "mineral yeast", as the product was called, was evaluated by Völtz[5], who found it to be of a high order.

During the same period, and in Great Britain, another type of protein from microbial sources was tried successfully in the rearing of pigs. The material was obtained from the bacterial residues accumulating during the manufacture of acetone and butyl alcohol by the fermentation of cereals. This bacterial residue, when fed to pigs on a restricted war diet, invariably gave a better rate of growth in the animals than the standard diet. At the time, no attempts were made to investigate the reasons for the observed beneficial effect, but it appears justifiable, in view of subsequent knowledge, to attribute it to the B vitamins and the high-grade protein contained in the bacterial residue.

With the end of the War of 1914–18 and notably since the start of the twentieth century, great interest has been taken in the dietetic value of micro-organisms both from the point of view of their protein content and afterwards of their vitamin content. Most of this work has been done on yeast, starting with the publications of Osborne and Mendel[6], who showed that rats thrive well on a diet containing brewers' yeast as the sole source of protein. Generalizing the various observations made, it may be claimed that yeast protein—the most extensively studied form of microbial protein—possesses a nutritive value only slightly inferior to that of a good animal protein. Of special interest are the observations of Macrae and his collaborators[7], who not only confirmed the earlier observations on the value of yeast protein but also showed that a comparatively small addition of microbial (yeast) protein to a diet containing only cereal protein of low dietetic value, such as maize protein, greatly increased the value of the latter in the rearing of pigs.

As regards the vitamin content of micro-organisms,

work done during the last twenty years has shown that these organisms constitute the most potent source of the water-soluble B vitamins known, and that many micro-organisms, including some forms of yeast, are able to synthesize B vitamins from inorganic sources, provided that carbohydrates are supplied for their growth.

Taken in conjunction with Macrae's observations on the value of microbial protein, it can now be appreciated how serious must have been the effect on the health of many native peoples of tropical countries to interfere with their consumption of home-brewed beers. For the diet of these peoples is essentially one of cereals, and frequently of cereals in which the protein is of low dietetic value. It is not to be wondered at that deficiency diseases attributable to lack of a vitamin B intake have increased in tropical countries with the sophistication of the native diet.

Once it had been established that micro-organisms form a valuable source of B vitamins and of protein of high nutritive value it became important to develop methods for the large-scale production of this concentrate in order to make it available for animal and human feeding purposes. Not unnaturally attention was again attracted to the surplus supplies of brewers' yeast, but the results achieved with this material were not always satisfactory, since the bitter taste of the yeast had to be removed to make it palatable. This was done by washing either with water or with dilute alkalis, a treatment which led to the destruction of much of its vitamin content. Nor were the available quantities of brewers' yeast likely to cover more than a fraction of the requirements likely to be needed in such countries where vitamin B deficiencies are seriously felt. To meet such a demand a new method of production had to be devised either along the lines adopted during the War of 1914–18 in Germany, or by any other method which might be found superior.

At the request of the Agricultural Research Council and the Scientific Committee on Food Policy, this work was undertaken by the Department of Scientific and Industrial Research in the microbiological section of its Chemical Research Laboratory at Teddington, where investigations on this problem have proceeded since 1940. In Germany, it is understood, parallel investigations have been going on simultaneously, but there the difficulty has arisen of a shortage of available carbohydrates, of which no supplies exist beyond the hydrolysate of waste wood—an entirely uneconomic raw material in normal times. Within the British Empire, on the other hand, a variety of cheap and surplus carbohydrates are always available in districts where the demand for the protein-vitamin concentrate is likely to be permanent. This has made it possible for the British investigators to concentrate their work on devising methods for the cheap production of the concentrate, an all-important aspect, seeing that the sections of society who are in greatest need of supplementary B vitamins are usually those who cannot afford the consumption of the standard sources of these accessory food factors such as meat, milk and eggs.

It may be of interest to mention here that the firm which has been chosen to produce the concentrate in Jamaica by the method finally adopted at Teddington estimates that the product can be marketed at about 6*d*. per lb. Seeing that a daily intake of ½ oz. of the product per person is contemplated, this figure should be low enough for the material to be within the reach of the poorest inhabitants.

One of the means by which this low cost has been secured has been to couple production with the working of a cane-sugar mill and thus to make use of available surplus quantities of molasses and of steam.

The type of micro-organism which for the time being has been chosen for the production of the concentrate is similar to that used in Germany and known under the name of *Torula utilis*. It was necessary, however, to develop from this organism a new strain which would grow well at temperatures higher than those tolerated by the standard strain, since the maintenance of the lower temperatures in tropical countries would have involved the adoption during manufacture of expensive cooling operations. It was desirable also to increase the size of the standard strain with the view of facilitating the separation of its cells from the medium in which they had been grown. Both these requirements have been met in the polyploid strain described under the provisional name of *Torulopsis utilis* var. *thermophila*. Another development in technique evolved at Teddington has contributed towards a reduction in manufacturing costs. In the usual methods of yeast production a five- to six-fold increase is anticipated in the weight of yeast introduced as inoculant into the nitrogen-carbohydrate solution in which the yeast is to be propagated during the usual nine-hour growth period. By the method worked out at Teddington this yield has been raised to a minimum of a fifteen-fold increase, thus making it possible to secure a greatly increased output of protein and vitamin from a given plant capacity or, alternatively, to produce a given output of concentrate in a smaller plant than would normally be needed.

Future work may show that another type of micro-organism may be preferable to *Torulopsis utilis* var. *thermophila*.

The yield of dry yeast, with five per cent of moisture, which is secured in the pilot plant working at Teddington, amounts to 30 per cent on the molasses used, assuming this to contain 50 per cent of sugar, or 60 per cent of dry yeast concentrate on the sugar used during the synthesis. The yield of crude protein in the yeast, as calculated on the inorganic nitrogen supplied during the growth period, represents an almost theoretical conversion.

When the period of growth has been completed the yeast produced is carefully washed with water in yeast separators, and the issuing yeast suspension passed over drying rollers, whence it issues as the final protein-vitamin concentrate. In this form it consists of light, straw-coloured thin flakes which have a pleasant nutty or meaty taste. It is now known under the name of "Food Yeast".

Besides the high protein content, which amounts to between 45 and 50 per cent, according to the methods of estimation, food yeast represents a potent source of B vitamins of which it contains the whole known range, including aneurin to the extent of 20 μgm. per gm.; riboflavin in absorbable amounts of 80–85 μgm. per gm.; and nicotinic acid 400–450 μgm. per gm.

It is readily miscible with water, soups, milk and stews. It can be incorporated into flour and thus baked to a loaf to which it imparts its slightly nutty or meaty flavour. Some very successful attempts have been made by the laboratories of the Co-operative Wholesale Society to produce a palatable

loaf and biscuits from flour incorporated with food yeast.

During the period covered by the investigations at Teddington it has been possible to supply food yeast to a number of workers who have been interested in determining its nutritive value. Reference has already been made to Macrae's work, which proved its value in pig feeding. Chick[8] found that food yeast added to white flour (73 per cent extraction) increased the value of such flour in rat feeding and made it equal in this respect to wholemeal flour.

Kay[9] at the National Institute for Research in Dairying reports that food yeast is an excellent and palatable high-protein food for pigs and young dairy stock and almost certainly for dairy cows in milk. It produces no intestinal or other disturbances.

In human nutrition, Stephenson, Penton and Korenchevsky[10] record preliminary observations on the value of food yeast when given to aged people with added ascorbic acid. These observers state that in suitable cases improvement in, or disappearance of, some pathological senile features was noticed.

Other workers have tried the value of food yeast in child nutrition; in cases of typical B vitamin deficiencies; in the treatment of jaundice and of certain forms of anæmia. Published reports on these tests are not yet available, but the general conclusion has been that the effect of the addition of food yeast to the patient's diet has been beneficial.

If it may be claimed, therefore, that the microbial protein and the B vitamin concentrate, food yeast, can supplement a restricted diet lacking in animal proteins and their accessory food factors, it is to be expected that the peoples of devastated countries in Europe and the Far East would benefit from its incorporation into their diet. For it is safe to predict that meat and other animal proteins will be in extremely short supply in devastated countries during the immediate post-war period. In fact, there is reason to expect that several years will lapse, after peace conditions have been re-established, before the destroyed herds of cattle of war-ravaged countries can be replaced and the agricultural output of meat and milk be increased to pre-war figures.

The quantities of food yeast which would be needed for incoporation into the restricted diet of Europe after the War could be rapidly provided, and often within the countries themselves, for food yeast production possesses an important advantage over meat production in that it can be completed in hours while meat production may take months or years. It would be essential, of course, to have a source of carbohydrate available, but in most devastated countries it should be possible within a single season to set aside a certain amount of carbohydrate for the purpose, either in the form of potatoes or of sugar beet. As for the inorganic nitrogen source required, this should be readily procurable during the post-war period. In this connexion it is worth recording that one acre under a carbohydrate crop could yield 840 lb. of protein in the form of food yeast but only some 70 lb. in the form of meat or milk protein, while the vitamin B output from the food yeast would be even more than proportionally higher. It is worth mentioning also that, at existing prices, beef or mutton proteins would be five time as dear as food yeast protein, milk protein eight times and egg protein twenty-four times as dear. The B vitamins of beef, mutton or milk would be twenty-five times and of eggs eighty times dearer than those of food yeast.

[1] Klöcker, "Die Gärungsorganismen", first edition, Max Waag, Stuttgart (1906).
[2] Märker, "Handbuch der Spiritusfabrikation", second edition, p. 480 (1877).
[3] Delbrück, Hayduck and Wustenfeld, "Jahrbuch des Vereins der Spiritus Fabrikantem in Deutschland", p. 25 (1910).
[4] Hayduck, *Z. Spiritusindustrie*, **38**, 161 (1915).
[5] Völtz, *Z. Spiritusindustrie*, **38**, 235 (1915).
[6] Osborne and Mendel, *J. Biol. Chem.*, **38**, 223 (1919).
[7] Macrea, El-Sadr and Sellers, *Biochem J.*, **36**, 460 (1942).
[8] Chick, unpublished data (1941).
[9] Kay, unpublished report (1940).
[10] Stephenson, Penton and Korenchevsky, *Brit. Med. J.*, II, 839 (1941).

DEVELOPMENT OF BIOLOGICAL SCIENCE IN RUSSIA

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THE history of the development of the natural sciences in Russia is closely connected with their powerful development in Western Europe and in North America. Indeed, during the initial period of the establishment of the exact sciences in our country, a number of distinguished European scientific men were invited to Russia where, living and working for long periods, they contributed many new pages to world science. Names of members of the Russian Academy of Sciences, such as Karl Ernst von Baer, Pallas, Bernoulli, Euler and others, are well known. Beginning with Michael Lomonosov, many Russian men of science worked and studied in famous laboratories of Great Britain, France and Germany. But it would be wrong to look upon the history of the development of the natural sciences in Russia—as historians of science often do—as only a result of the activities of those great men of science from Western Europe who came to Russia and pursued their work in the young Russian Academy of Sciences.

Special importance in the history of the development of the exact sciences is attached to the nineteenth century, "the century of natural sciences" as K. A. Timiryazev has repeatedly called it. The main edifice of the natural science of the nineteenth century was constructed in friendly international collaboration by the scientific workers of the Old and New World, and in this work Russian men of science were the originators of a number of important and independent branches of natural science.

The beginnings of an independent science in Russia emerged in the second quarter of the nineteenth century in an atmosphere of exceptionally intense intellectual activity, and were the result of the great social movement in Russia of the 'fifties and 'sixties which laid the foundation for the emancipation of the peoples of Russia from reaction in all its manifestations. It came into being as a result of the independent critical advancement of the best achievements of human culture. By the end of the 'fifties, inspired by the philosophical and scientific works of his remarkable compatriots, B. G. Belinsky and A. I. Herzen, N. G. Chernishevsky wrote: "In their conceptions these people no longer depended

on foreign authorities", and that "Here, for the first time, the intellectual life of our fatherland created men who marched abreast of the thinkers of Europe and not, as had been the case previously, in the ranks of their disciples".

These words, a reflection of "national pride" (Chernishevsky's words), were expressed in the years when there began to appear the first galaxy of Russian men of science, who brought so much glory not only to the Russian people but also to all mankind. The names of Sechenov, Mendeleev, the brothers Kovalevsky, Mechnikov, Pirogov, Butlerov, and, later, Pavlov, Timiryazev and Michurin, speak for themselves.

Long before this period, in the eighteenth century, the work of Michael Lomonosov, son of a Pomor peasant, in physics, chemistry, mathematics and literature entitled him to a place beside the founders of modern exact science—Copernicus, Newton, Lavoisier. As it is now known, Lomonosov, with the vision of a genius, foresaw and created the foundations of a number of new branches of the natural sciences. Unlike his predecessors—the brilliant Western European naturalists and philosophers of the seventeenth century—he not only stood at the peak of knowledge of his own times but also mapped the course of development of the following century. In an address in 1924 on the role of Russian chemistry in world science, Prof. W. P. Wynne, then president of the Chemical Society of London, stressed the fact that even before Lavoisier, Lomonosov had formulated the principles of the chemical theory of combustion and respiration. In fact, the works of Lomonosov have actually provided the impetus for the development of such young branches of natural science as physical chemistry and chemico-physics.

Appearing at the beginning of the nineteenth century, the brilliant mathematical works of Lobachevsky have for many decades and right up to our own days impregnated world mathematical thought. Clifford has vividly described the importance of his work. He declared: "What Vesalius was to Galen, Copernicus to Ptolomeus, Lobachevsky was to Euclid".

By the 'fifties of the nineteenth century the fame of the Russian organic chemists (Zinin, Butlerov and their disciples) had spread across Europe. Their achievements in the synthesis of organic compounds brought into existence a whole line of followers. A number of investigations were carried out by the German chemist, Hofmann, to repeat, confirm and interpret the achievements of the famous Russian organic chemists who worked in the modest laboratory of the University of Kazan, where Lobachevsky was carrying out his scientific exploits. The principles of the artificial synthesis of pigments worked out by Russian chemists re-equipped the technological processes of certain branches of European industry, of German industry in the first place. Certain German chemists have in the past tried to dispute the discovery of the periodic system of elements by the immortal Russian chemist, D. I. Mendeleev. But these attempts were and will be in vain; Mendeleev's work is the basis of modern chemical conceptions.

It is not possible here to discuss the significance of the works of Russian men of science in the development of physics and also of electro-technics. The names of Petrov, Yablochkin, Ladygin, Popov, and finally the brilliant physicist, Lebedev, are associated with the hypotheses and technique of modern physics; to this important section of the history of Russian thought, specialists must give serious attention.

At the beginning of the 'sixties the famous Russian biologists on whose activities we can dwell here in more detail joined the ranks of the great naturalists of the nineteenth century. First of all, it is necessary to emphasize the role of the Kovalevsky brothers, Alexander and Vladimir. Alexander Kovalevsky showed for the first time that there exist organisms which represent a transitional form between invertebrates and vertebrates. These were the ascidians, which he studied in detail. The German scientific worker, Kupfer, repeated the experiments of Kovalevsky, whose findings and conclusions he confirmed.

At a meeting of the Royal Society of London, a report was given on Kovalevsky's discovery which, as was stated by T. H. Huxley, then president of the Society, created a great impression. Carefully studying Kovalevsky's works, Charles Darwin wrote to Kovalevsky's brother, Vladimir: "Few men will have made such fine discoveries as your brother". It is possible to say without exaggeration that one of the most authentic and convincing proofs of Darwin's evolutionary theory is the group of facts discovered by A. Kovalevsky, one of the world's greatest embryologists, which have been confirmed and recognized by his numerous followers in Europe and America.

In the conversation that took place when K. A. Timiryazev visited Charles Darwin in his house at Downe, in 1877, the latter spoke with particular esteem of the works of the Kovalevsky brothers, especially those of Vladimir. V. Kovalevsky is acknowledged by world science as the founder of evolutionary palæontology. Having explored the vast material on fossil vertebrates, V. Kovalevsky mapped entirely new paths in the field of palæontology and, indeed, laid the foundations of historical palæontology. After visiting a number of European geological and palæontological laboratories, he justly complained of the fact that though many European investigators of his own time were working on important fossil organisms, their work remained a mere description of forms "without any conclusions". This latter impression V. Kovalevsky confided to his brother in a letter referring to German workers in particular. In spite of the fact that V. Kovalevsky actually had no chair and no laboratory and was compelled, because of material difficulties, to do work unconnected with science, the greatest palæontologists of Europe and America are proud to consider themselves his disciples. In his review of the history of palæontology, Henry Fairfield Osborn stated that the works of V. Kovalevsky opened "a new era in palæontology . . . [they] swept away all the dry traditional European science of fossils".

With a feeling of deep national pride we must note the fact that among the founders of modern medicine, world science has given to Ilya Mechnikov an honourable place alongside the Frenchman, Pasteur, the Briton, Lister, and the German, Koch. If, with burning conviction, Pasteur and his followers proved that the leading part in the inception and development of diseases in human beings, animals and plants is played by the infection of these organisms with disease-bearing bacteria, to Mechnikov belongs the honour of revealing the main ways in which the struggle goes on between the organisms and the microbes. The Mechnikov theory of phagocytes, so brilliantly argued with much comparative pathological data, actually laid the foundation for modern

teaching on the process of immunization of organisms to diseases and on the means by which the organisms fight the diseases.

One of the greatest achievements in the field of medicine is the discovery of filtrable viruses. Not very long ago, in 1938, in a résumé devoted to this problem, Anton Dohrn tried to prove that the discovery of filtrable viruses belonged not to the Russian scientist D. O. Ivanovsky but to German investigators. But facts are stubborn things; it was Ivanovsky who, on February 12, 1892, in his report to the Russian Academy of Sciences, for the first time presented data which laid the basis for modern teaching on filtrable viruses. The whole of world science, including the best modern experts on this question, headed by the American, Stanley, who in 1935 discovered the crystalline nature of filtrable viruses, recognizes Ivanovsky as the "father of virus research".

An honourable place among the founders of modern medicine is rightly occupied by N. I. Pirogov, the Russian surgeon, a pioneer of field surgery. A number of classical operations originated by him have not, even at the present time, been excelled in their daring and brilliant simplicity. He methodically worked out the foundations of modern topographical anatomy. Finally, to Pirogov and his disciples belongs the idea and realization of the new method of anæsthesia, the so-called non-inhalational narcosis which, known as the "Russian method", has been widely adopted.

When the young Russian physician, Ivan Sechenov, whose mother was a Kalmuk peasant, first appeared in Western Europe in 1857–58, he soon attracted the attention of noted European scientific workers. Already in his first published work this twenty-seven-year-old physiologist discovered and made known the experimental mistake of the celebrated physiologist of the nineteenth century, Claude Bernard. In the very same year the great German physiologist, Helmholtz, wrote that in his laboratory Sechenov had made an important discovery about crystalline fluorization and that in this sphere the work of the Frenchman Renault lagged behind the work of Sechenov in every respect.

Starting work in the laboratory of the brilliant master of physiological experiment, Karl Ludwig, Sechenov realized the inadequacy there of experimental methods for studying the gases of the blood, and he embarked on independent work in this difficult field. Sechenov constructed a special apparatus for the study of gases of the blood which he called the "absorbtometer". Ludwig ordered Sechenov's apparatus for his own laboratory. Experimenters like Helmholtz, Pflüger, Bohr, and, later, Warburg and Barcroft, introduced a number of modifications to the basic model created by Sechenov. Widely used in all modern physiological and biochemical laboratories of the world, appliances for studying gases of the blood and also respiration of the tissues are, despite many small modifications, only variations of Sechenov's model.

In his discoveries of the phenomena of central torpor in the highest sections of the nervous system of animals and man, Sechenov's work has received world recognition. Up to now physiologists of all countries have continued to work on the interpretation of the phenomena discovered by Sechenov. Long before many of the greatest physiologists of modern times, especially the famous British physiologist, Sherrington, and the German physiologist, Hofmann, Sechenov discovered and described in great detail the complicated phenomenon known as muscular sensation. He noted for the first time that the muscular system of animals and man is at the same time the system of the organs of sensation, which fact had great importance in the co-ordination of movements of these organisms. The most complicated physiological laws which underlie the latest conclusions on the mechanism of the co-ordination of movements (particularly the question of so-called antagonistic excitation of the muscles) were originally described in Sechenov's works. First to direct attention to all these facts was Prof. A. F. Samoilov, famous for his work on the physiology of the nervous system.

It is difficult to over-estimate, and even still more difficult to deny, the all-important part played by Sechenov in the discovery of a completely new approach in the physiology of the nervous system, which made possible the objective study of such complicated phenomena as the conduct of animals and human consciousness. This indisputably Russian trend in world physiology was brilliantly developed by Sechenov's closest follower—the scientific genius, I. P. Pavlov.

Among the direct disciples of M. Sechenov we must note the name of one of the greatest Russian physiologists, N. E. Vedensky, who developed Sechenov's work and discovered a number of new laws relating to the most complex questions of the activity of the nervous system. It is possible to say without exaggeration that contemporary physiology of the nervous system is nourished to a great extent by ideas and experimental data belonging to Vedensky or connected with his name. It is well known how much attention British and American schools of physiology have devoted to the elaboration of Vedensky's scientific heritage on the most delicate processes of excitation and torpor of nerve cells and nerve fibres. At the International Congress of Physiologists in 1935, Prof. Louis Lapic, of the Sorbonne, admitted that his own teachings on chronaxie were without any doubt formulated in other terms by Vedensky long before him.

It is unnecessary to speak of the fame of Pavlov and his school. He has been well appraised by the American physiologist Prof. W. B. Cannon: "if they do not know about him they think according to Pavlov's ideas, and if they do not think according to his ideas, their digestion works along those lines".

At the end of the nineteenth century, when Pavlov's book "Lectures on the Work of the Digestive Glands" appeared, the celebrated German physiologist, Funk, observed: "it is difficult to find a scientist who in so short a time has been able to make so many discoveries". Meeting in the U.S.S.R. in 1935, the International Congress of Physiologists unanimously recognized Pavlov as "leader of the physiologists of the whole world". The works of Sechenov, Pavlov, Vedensky and their disciples have won a prominent position for the Russian school of physiology.

The end of the nineteenth century was marked by discoveries by Russian scientific workers which illuminated the most important processes of organic matter—the processes of the synthesis and decomposition of organic matter, and the changes of matter in Nature. On the basis of brilliant and careful experiments, K. A. Timiryazev established new conceptions of the role of chlorophyll and the energy of light in the synthesis of organic matter from carbon dioxide and water. The work of S. Vinogradsky led to the understanding of another most important branch of the synthesis of organic matter in Nature, namely,

the 'fixation' of nitrogen of the air by the synthesis of complex organic nitrogen compounds. Vinogradsky's discovery of the relation of atmospheric nitrogen to soil bacteria represents a new epoch in biology and agriculture.

From different aspects, the work of V. Paladin and A. Bach led to an understanding of the biochemical processes forming the basis of the respiration of plants and animal cells.

From its inception the evolutionary teaching of Charles Darwin had ardent protagonists in Russia among philosophers and scientific men such as Pisaryev, Timiryazev, Mechnikov, and, later, Mensbir and A. N. Severtsov. At the very beginning of the twentieth century, simultaneously with Sedgwick, A. N. Severtsov widened and deepened Darwin's teachings by his work on the study of the relationship between the individual and the evolutionary development of organisms.

All these achievements of Russian biologists during the nineteenth century form the basis for the many-sided development of science in Russia which has characterized recent years. Scientific men of the U.S.S.R., fully aware of their debt to their people, always remember the words of one of their teachers, I. P. Pavlov, who said: "Our fatherland opens vast fields to scientists, and it is necessary to repay the debt; science is generously introduced into the life of our country—to the last degree, generously . . . and for us it is a matter of honour—to fulfil the great hopes that our country places on science".

ASPECTS OF INDIAN INDUSTRIAL DEVELOPMENT

PRIOR to the War of 1914–18, Indian industrial development, except for the textile industries based on cotton and jute, were on a minor scale. The great Tata iron and steel works at Jamshedpur were still in process of erection and it was not until after 1917 that it was in a position to make a major contribution to the war effort. Public opinion had already forced the Government of India to recognize the desirability for a more rapid industrial development, resulting in the appointment of the Indian Industrial Commission. Unfortunately, many of the recommendations made in the Commission's valuable report were not implemented, nor was much attention paid to the suggestions for the development of chemical and metallurgical industries made in the pamphlets issued by the Indian Munitions Board. The temporary impetus resulting from the War soon died down and almost the only large-scale industry based on science which developed during the next two decades was that of soap and related products, manufactured by modern methods, in the Tata Oil Mills. It would serve little purpose, nor would it indeed be profitable, to discuss the varied causes for this, but one of the main causes has undoubtedly been lack of adequate technical advice and of skilled labour.

Now, with another war of world-wide range, the opportunity has once more arrived for India to become industrialized, and this time we feel there can be no relapse. As a supply centre for the Near and Far East she occupies a key position. This time it is possible for the advance to be planned and to be based upon solid scientific research. It is true that for many years now, cotton, jute and lac have had their research organizations, and therein lies probably the cause of their prosperity, but planned industrial research on the many problems of the chemical and metallurgical industries under tropical conditions has been almost completely lacking. This gap has now been filled by the new Board of Scientific and Industrial Research. A further guarantee that the fundamental chemical industries will be established on an adequate scale is furnished by the decision of Imperial Chemical Industries, Ltd., to form an Indian company. We may anticipate that this will meet with success equal to that achieved by the similar organizations in South Africa and Australia.

Rich as India is both in mineral and plant products, she is, like other countries, by no means fully self-sufficient. The main coal deposits are situated far from the Punjab, Bombay and Madras, although this lack of fuel is to some extent compensated by cheap electricity generated by water-power. A further fundamental requirement is sulphur for the manufacture of sulphuric acid, since even now it is true that the consumption of sulphuric acid provides an index of a country's industrial development. India drew her supplies of sulphur almost entirely from enemy countries, Italy and Japan, and although the immediate war-time needs are being met from the comparatively small deposits in Baluchistan, these, besides being difficult of access, would be quite inadequate in normal times. A nearby and practically inexhaustible source of supply could be made available by the desulphurization of the waste gases from the Anglo-Iranian oil-fields. In an interesting paper, Forrester and Gilbert (*Trans. Min., Geol. and Metal. Inst. India*, **37**, 61–168; 1941) have surveyed some aspects of chemical and metallurgical industries as applied to Indian conditions, and they suggest that considerable quantities of sulphur dioxide could be recovered from the Indian Copper Corporation's smelting plant. This source, were it developed, would, however, only very partially meet India's normal requirements, and other sources will have to be found. The former possibility would appear to be worthy of careful consideration, since it would at the same time give a gas suitable for the manufacture of a high-class carbon black.

Whereas the metallurgical industries based on iron are already developed on a large scale in India, no attempt has been made so far to establish the manufacture of either aluminium or magnesium, although much has been written on the subject. For the manufacture of the former, both the necessary raw materials and cheap electrical power are available, so that presumably lack of capital and of adequate scientific assistance have caused the delay in the establishment of this essential industry. The growing importance of the lighter alloys would justify also the manufacture of magnesium, for which the separation of magnesium salts from sea water by modern methods would provide the necessary material.

In their paper, referred to above, Forrester and Gilbert tabulate a long list of coal-tar products which are now being made in India; but with the relatively small and scattered gas plants which are in operation, it would appear doubtful if a large-scale industry—and to be economically successful it must be on a large scale—can be developed from coal-tar. It would seem that in India a synthetic chemical industry

must be based on different materials, and for such new developments she is not ill-situated. There are in Assam and in the Punjab developed sources of petroleum, and even if these fields are relatively small as compared to those of Russia and America, they should provide sufficient materials for the manufacture of chemicals which recent research has shown to be readily obtainable from the oil and gas. It seems likely also that the manufacture of calcium carbide will soon be undertaken, and if this were done, acetylene would be available from which, as has been found in Canada, a host of subsidiary chemical industries can be developed. Finally, thanks to the research work initiated by Barber at Coimbatore and since extended by many other workers, cane sugar is now produced on a very large scale. By well-established processes, sugar provides a source of a great variety of products such as alcohol, acetone, butanol, citric and gluconic acids.

In India, a chemical industry based upon petroleum, sugar and calcium carbide might prove to be far more economical than one based upon coal tar. Development on these lines will necessarily involve much fundamental research and may appear to be speculative at the present time, but it seems to be more likely to lead to success than one based on older and well-established methods. It would certainly be profitable for the younger chemists now being trained in India to devote some of their energy and skill to a consideration of these problems. A further large field for research is to be found in the development of India's reserves of cellulose. In Sweden the exigencies of war have emphasized how very valuable a raw material this is. In the post-war years, we may anticipate that India will lead in this and in other fields of technical research.

PIONEERS OF REFRIGERATION*

By ENG.-CAPT. EDGAR C. SMITH, O.B.E., R.N.

DURING the greater part of the nineteenth century, there was a considerable trade in natural ice, and ice cut from Wenham Lake, near Boston, in the United States, was known in many parts of the world. Some of this ice came to Great Britain, which also obtained supplies from Greenland and Norway. It was this trade which led the famous engineer, Richard Trevithick, in 1828 to suggest to his friend, Davies Gilbert, that ice could be made by the compression and expansion of air.

The earliest apparatus for making artificial ice was that of William Cullen, who described his water evaporating device so long ago as 1755, while he still held the chair of chemistry at Glasgow. He was the first of many Scotsmen to further the practice of artificial cooling, and about half a century after he had made his evaporation apparatus, John Leslie, while holding the chair of mathematics at Edinburgh in 1810, devised his water absorption apparatus, in which water evaporated in a vacuum was absorbed by sulphuric acid. Writing in the seventh edition of the "Encyclopædia Britannica", Leslie referred to his method of "producing congelation on a large scale" and added that with a proper system of air-pumps, worked by a steam engine of six horse-power, it might be possible in the climate of London to produce ice at the rate of a ton a day. The need for means of cooling was felt most in breweries, and the patents taken out for cooling worts and other liquids are very numerous. The first of such patents is that taken out in 1819 by Robert Salmon, the ingenious mechanist to the Duke of Bedford, at Woburn Abbey, in conjunction with William Warrell. This patent was No. 4331 of January 15, 1819.

As is well known, the three principal types of refrigerating plant which have been used on a large scale are the ammonia absorption machine; the air refrigerating machine, first visualized in a crude manner by Trevithick; and the vapour compression machine, the first example of which was made in an East London engineering shop for the American engineer, Jacob Perkins (1766–1849), according to his patent No. 6662 of August 14, 1834. Though a trial was made with the Perkins machine, it was not very successful and the inventor, having many other things on hand, did not pursue the matter.

About ten years later, the idea of using machines for cooling air in sick-rooms, hospitals, etc., occurred almost simultaneously to the American physician, James Gorrie (1803–55), of Apalachicola, Florida, and to the Astronomer Royal for Scotland, Charles Piazzi Smyth (1819–1900). Both these men spent about ten years trying to develop their ideas, and on May 6, 1851, Gorrie secured the United States patent No. 8080, the first patent for an air refrigerating machine. Smyth in his work had the assistance of Rankine, and of James Stirling, the brother of the Rev. Robert Stirling, who had invented the hot-air engine. Though Smyth's proposals were the subject of a report to the Indian Government, nothing came of them. Gorrie, on the other hand, did apparently see some of his plans adopted, but when he tried to get them introduced on a larger scale, his funds failed, his health broke down and he died at the early age of fifty-two. His merits, however, have not been forgotten and his statue now stands in the Statuary Hall, Washington, D.C.

By the time of Gorrie's death, artificial cooling had become a matter of great interest in Australia, where some far-sighted individuals saw that the surplus meat of the Colonies would readily find a market in Europe if means existed of preserving and transporting it. Among those whom this question stimulated was the Scottish journalist, James Harrison (1816–93), and the Lancashire wool broker and business man, Thomas Sutcliffe Mort (1816–78), both of whom had emigrated to Australia about 1838. Harrison had a long career as a journalist and at one time edited the *Melbourne Age*. He was also the parliamentary representative for Geelong, Victoria, where he had settled. It is said that he corresponded with Faraday and Tyndall, but however this may be, in the 'fifties he began experimenting on ice-making, and in 1855 took out an Australian patent; then coming to England, he secured patents No. 747 of March 28, 1856, and No. 2362 of September 10, 1857, for a vapour compression machine using ether. His earliest machines were made in Holborn by the German engineers, Siebe Brothers, the founders of the well-known firm, Siebe, Gorman and Co., Ltd., the first machine being set up at the famous paraffin works of James Young at Bathgate, Scotland, the cradle of the Scottish shale oil industry. Previously, to separate the solid paraffin from the oil, it had been necessary to store the oil in summer and then expose

* Substance of a paper read before the Newcomen Society on March 10.

it in flat dishes in winter. Another Harrison machine was set up at the brewery of Truman, Hanbury and Co., Ltd., London, and a third was taken back by Harrison to Australia, where his machines were afterwards made in the works of P. N. Russell and Co., of Sydney.

The introduction of the Harrison machine had two unexpected results: it led to the Siebe firm becoming makers of refrigerating plant, and to the invention by Alexander Carnegie Kirk (1830–92), the engineer of the Bathgate paraffin works, of the closed-cycle air refrigerator which he described very fully to the Institution of Civil Engineers in January 1874, when one of his machines had been running successfully for ten years. Kirk had had a good scientific and practical training, and afterwards became widely known as one of the chief pioneers of the marine triple expansion engine. His refrigerating machine was introduced because the use of ether had been found dangerous and the Harrison machine too small. In his inquiries, Kirk learnt about Gorrie's machine and also studied the Stirling hot-air engine.

Meanwhile, there had been progress in other directions. In 1860, Ferdinand Carré patented the ammonia absorption machine; in 1861, Mort at Sydney founded the first freezing works in the world; in 1864, Charles Tellier (1827–1913), the French pioneer of cold storage and of marine refrigeration, took out his first British patent; in 1867 the American inventor, Thaddeus S. C. Lowe (1832–1913), was granted provisional protection for a patent which included the use of liquified carbonic acid, and in 1869 Franz Windhausen, of Brunswick, secured a British patent, the first of several, for a cold-air machine. To this period also belong some of the patents of Mort, who had the assistance of the French engineer, E. D. Nicolle, manager of P. N. Russell and Co. Applications for patents in connexion with cooling were reaching the British Patent Office at this time at the rate of about one a week.

The next decade, 1870–80, was perhaps the most fruitful, as it is certainly the most interesting period in refrigeration history. It saw the initial work at Munich of Carl von Linde, the introduction of his ammonia compression machine and the founding at Wiesbaden of the Gesellschaft für Linde Eismachinen; the invention in France by Paul Giffard of an air machine which was taken up and improved in England; the introduction by Raoul Pictet, of Switzerland, of the use of sulphur dioxide as a refrigerant; the building by Tellier of a cold store at Auteuil and the fitting out by him of *Le Frigorifique*, the steamer which in 1876 brought a consignment of meat from the Argentine to France; the collaboration of the Bells with Coleman, which resulted in the voyage of the first refrigerator ship on the North Atlantic and the voyage of the first refrigerator ship to carry meat to England from Australia; and also the early work of Alfred Seale Haslam (1844–1927) of Derby, of Thomas Bell Lightfoot (1849–1921), the founder of the Lightfoot Refrigerator Co., and of Everard Hesketh (1854–1942), for fifty years the inspiring head of H. and E. Hall, Ltd., of Dartford. Hesketh, who died at Johannesburg last year, was the last of this band of pioneers.

Of outstanding importance was the work of Joseph James Coleman (1838–88), with whom the Bells formed the Bell-Coleman Mechanical Refrigeration Co., of Glasgow. Henry Bell, born in 1848, and James Bell, born in 1850, were the sons of John Bell, a successful Glasgow butcher, whose business they carried on and extended, possessing in the end more than three hundred shops, which passed into the hands of Eastman, of New York. In the middle 'seventies, a certain amount of meat was imported from North America in ships fitted with ice chambers. Looking for better means of cooling, the Bells sought the advice of Sir William Thomson (Lord Kelvin), by whom they were placed in touch with Coleman, who curiously enough was research chemist at the Bathgate oil works. Born in Lincolnshire in 1838, Coleman had passed his youth with a pharmacist in Halifax, where he attended the Mechanics' Institute. His progress was such that at the age of twenty-two he contributed a paper to the British Association on atomic weights and atomic volumes. For several years he taught science in Chester Training College, but was led to the study of mineral oil manufacture and was offered the post at Bathgate. While there, in 1874, he patented a machine for compressing and cooling the waste gases from shale oil works, this machine being the precursor of his cold-air refrigerating machine, patented jointly by Coleman and the Bells on March 3, 1877. With the assistance of D. and W. Henderson, shipbuilders and engineers, of the Clyde, experiments with machines, insulation and so forth were carried out, and in 1879 a Bell-Coleman machine was placed on the Anchor liner *Circassia*, in which Coleman made a trip to and from America.

The results of this trip were so successful that the Anchor Line decided to fit up all its thirteen ships in the same manner. The second Bell-Coleman machine, however, was not placed aboard a liner but aboard the cargo boat S.S. *Strathleven*, which had been chartered by Messrs. McIlwraith, McEacharn and Co. to make an experimental trip to Australia and back. Unlike to-day, the meat was taken on board fresh and then frozen. Having received and frozen a consignment of about forty tons, the *Strathleven* left Sydney on November 29, 1879, and Melbourne on December 6, and arrived in London on February 2, 1880, with the meat in good condition. Two years later, the sailing ship *Dunedin*, fitted with a Bell-Coleman machine, brought home the first cargo of frozen meat from New Zealand. By then other engineering firms had begun the construction and installation of air refrigerators, and in the early 'eighties the Bell-Coleman patents were acquired by Haslam. Coleman retired to Bearsden, near Glasgow, where he died at the age of fifty. Both the Bells, on the other hand, lived to a good age, and both were made baronets for their public services.

While von Linde in Germany found the widest scope for his activities in installing ammonia compression plants in breweries, British refrigerating engineers were more concerned with the new frozen meat industry. Cold-air machines continued for many years to be fitted in both cold stores and in ships, but the higher efficiency of ammonia and carbonic acid machines gradually gained them a place in the food industry, ammonia machines being installed in large numbers ashore and carbonic acid machines in ships. There was at first a prejudice against the use of any chemicals afloat, and there was always a question of supplies when ships were abroad. These factors also affected the introduction of refrigerating plant into men-of-war when the cooling of magazines was found necessary. The first mercantile vessel with a carbonic acid machine for carrying meat was the ***Highland Chief***, 1890. The first British man-of-war with a carbonic acid magazine-cooling plant was the battleship ***Sans Pareil***, 1897.

OBITUARIES

Sir Sidney Gerald Burrard, Bart., K.C.S.I., F.R.S.

SIDNEY GERALD BURRARD was born on August 12, 1860. He was the eldest son of Lieut.-Colonel Sidney Burrard of the Grenadier Guards, and was born at Yarmouth, Isle of Wight, in the Dower House built by his grandfather, the Rev. Sir George Burrard of Walhampton. His first school was Uppingham, where Thring was headmaster, but later he was transferred to Wellington, chiefly for the sake of the shorter journey from his home. From Wellington he went up for Woolwich and passed in at the head of the list. He was at the R.M.A. until September 6, 1879, when he received his commission in the Royal Engineers. After two years at the School of Military Engineering, Chatham, he sailed for India. In September 1884 he joined the Survey of India and was posted to the Trigonometrical Branch, in which he so greatly distinguished himself.

A brief outline, with a more detailed account of his most notable achievement, must suffice for this short notice :

1884–94 : latitude and longitude observations with some periods at the headquarter office.

1894–96 : redetermination of the longitude of India from Greenwich, via Germany, Russia, Persia and the Persian Gulf.

1896–98 : tidal and levelling operations.

1898, January : in charge of a camp for the reception of astronomers visiting India for the observation of the total eclipse of the sun. The Astronomer Royal (Sir William Christie) and Prof. H. H. Turner of Oxford were the principal guests.

1899 : became Superintendent of the Trigonometrical Survey.

1901 : published the paper entitled "The Attraction of the Himalaya Mountains on the Plumb Line in India".

1904 : elected to the fellowship of the Royal Society.

1906–7 : published, in collaboration with Sir Henry Hayden, "A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet".

1909 : while on furlough attended the general assembly of the International Geodetic Association in London and Cambridge.

1911 : appointed Surveyor-General of India.

1912 : received C.S.I. at the Delhi Durbar.

1913 : awarded the Victoria Medal by the Royal Geographical Society.

1914 : made K.C.S.I.

1915 : tenure of the office of Surveyor-General extended for the duration of the War.

1919 : Retired from the Service.

After retirement Sir Sidney bought a house at Farnborough and settled there.

In 1933 he inherited the baronetcy of Walhampton from his cousin and became seventh baronet.

All Burrard's work during his long career was excellent, but his great contribution to knowledge was contained in the paper published in 1901 entitled "The Attraction of the Himalaya Mountains on the Plumb Line in India". To make the nature of this contribution clear, it will be necessary to explain the state of opinion on the subject of mountain attraction which prevailed before this paper was published. One must go back to the observations of Everest and Waugh and the calculations of Pratt. The discrepancy between the observed attractions and the results of Pratt's calculations showed that the apparent added mass of the mountains must somehow be balanced by a deficiency of mass in the crust underneath them. This led to the theory of mountain compensation. It was shown by observation that the deflexion of the plumb line towards the mountains was quite large at places close to them, but that it petered out rapidly and quite disappeared at a moderate distance from them. If then the effect of the great Himalayan ranges does not extend far, it follows that all deflexions found at more remote stations of observation must be due to local causes, visible or subterranean, and that they would therefore resemble random errors unconnected with any structural principle, and ought to be dealt with in further determinations of the figure of the earth by taking the average of a large number of observations evenly spread over a large area. To secure an adequate number of such observations had been the aim of the programmes of latitude determinations which had been systematically carried out, and by the end of the last century a considerable number of results was available. Burrard soon noticed that the arrangement of the deflexions was not random at all, and he then proceeded to study the whole question.

The outcome of this study was the paper mentioned above, in which three major conclusions are arrived at :

(1) The distribution of deflexions of the plumb line is not random but systematic. The deflexions are arranged in zones and these zones are parallel to the curve of the Himalaya Mountains.

(2) No arrangement of mountains and their compensation, whether the latter be situated near the surface or at a great depth, is capable of producing large deflexions at places close to the mountains and small deflexions at places moderately distant from them.

(3) It follows that to account for the observed facts a second cause is required, and a hidden range of high density running across India, parallel to the Himalayas, and with its crest some 400 miles from the foot of the mountains, would be a possible explanation.

The immense importance of these conclusions, especially of the first, is easily seen. Whereas hitherto deflexions of the plumb line had seemed to be unconnected with the tectonics of the earth's crust and therefore of little interest, it was now shown that they were closely bound up with mountains and mountain compensation, and would repay intensive and systematic study. This discovery had a profound effect on all geodetic thought, and from the time of its publication the study of the nature and extent of mountain compensation by means of the observation of gravity anomalies, whether in direction or intensity, has become a major field of scientific inquiry.

Space does not permit of further description of Burrard's attainments or of his personality and character, but as one who had been his colleague for thirty years, intimately acquainted with all that he thought or did, and who continued for twenty more years to be on terms of the closest friendship with him, I may say that there never was a man more delightful to work with, and that he never gave his mind to any subject, music, art, history or science, without throwing some new light upon it. His conversation was the most refreshing and stimulating that I have ever known, and his death leaves a blank that cannot be filled.

G. P. LENOX-CONYNGHAM.

Prof. F. G. Parsons

To many generations of men who received their medical training at St. Thomas's, the news of the passing of Frederick Gymer Parsons in his eightieth year must come with a sense of personal loss. For Parsons had a personality that could never be forgotten, and into every picture of the Medical School of St. Thomas's there must come, in the memories of hundreds of medical men, a kidney-shaped table and, standing in its concavity, a powerfully-built man with an enormous red moustache. The students sitting round the convexity of the table knew him as a teacher; but many knew him as more than that, for there was no form of student activity he did not foster, no work for student enterprises or welfare he ever found too arduous or ever left undone.

Of those who still cherish such happy memories of Parsons the majority are now in middle life, for his retirement from active teaching took place many years ago. But well past middle life are those who knew him at the height of his activities, when all his great energies were directed towards the subject that he made his own. When Parsons was laying the foundation stone of the work on comparative anatomy by which he must ever be known, London was, from an anatomical point of view, an 'island' of English anatomy entirely surrounded by Scotsmen. In the 'island' were, among others, C. B. Lockwood and G. D. Thane, G. B. Howes and Christopher Addison; and of that group Lord Addison is the only one who remains with us.

These men were making London an anatomical centre equalling in its reputation the traditional glory that clung to Edinburgh. All were what the younger generation of anatomists would now stigmatize as 'old-fashioned', for some were mainly concerned with the Hunterian tradition, some with human topographical anatomy and some, like Parsons, with comparative anatomy. It was mammalian myology to which Parsons devoted most of his energies for research, and this subject and the anatomy of mammalian joints he made his own. He dealt in facts—facts laid bare by his scalpel; and as a storehouse of facts his works are permanent.

It was considerably later that Parsons became especially interested in physical anthropology and made his valuable contributions to our knowledge of the osteology of the earlier inhabitants of England. In all his later work he found much interest in the historical setting of the Saxon Englishman. In this setting he saw even a personal intimacy, for he conceived himself to be representative of the typical Saxon, and probably he was near the truth in this. He loved the sea. He had spent happy years as ship's surgeon. True to the traditions of the sea he loved the countryside, and he had that age-long hankering of the sailor to settle down in retirement in a country inn with roses near the front door.

Parsons lost one great ideal when the tragic death of his wife nearly thirty years ago sundered a perfect partnership. Parsons was a man. He took this great blow like a man. His many friends must rejoice in this, that though he lost his great ideal, he did what many others have failed to do. An active life of devoted and useful work and of scientific attainment passed over into years of happy and contented retirement; and in the end and at the "Swan" in Thame he lived to see one of the dreams of his youth come true.

F. WOOD JONES.

WE regret to announce the following deaths:

Prof. P. P. Bedson, emeritus professor of chemistry, Durham College of Science, Newcastle-upon-Tyne (now King's College, University of Durham), on April 4, aged ninety.

Sir Edwin Butler, C.M.G., C.I.E., F.R.S., formerly director of the Imperial Mycological Institute, Kew, and secretary to the Agricultural Research Council, on April 4, aged sixty-eight.

Dr. H. Forster Morley, formerly director of the International Catalogue of Scientific Literature and of the Royal Society's Catalogue of Scientific Papers, on April 3, aged eighty-seven.

Mr. R. A. Roberts, a Royal Commissioner for Historical MSS., and formerly senior assistant keeper in the Public Record Office, on April 2, aged ninety-one.

NEWS and VIEWS

Sir Frederick Gowland Hopkins, O.M., F.R.S.

SIR FREDERICK GOWLAND HOPKINS' published contributions to biochemistry are well known; but as the time approaches of his relinquishing the Sir William Dunn chair of biochemistry at Cambridge, it is perhaps opportune to try to appraise his influence on the progress of the subject from 1899, when he took up work at Cambridge, to the present time. It has frequently been said in Great Britain during these years that "Hopkins *is* biochemistry"; when he decided to make this subject his own, biochemistry, as he visualized it, scarcely existed either in Great Britain or on the Continent. This is not to minimize the monumental achievements of such men as Emil Fischer and Albrecht Kossel, his immediate forbears; but while he fully appreciated the value and significance of this work, Sir Frederick visualized something beyond the isolation and description of the products and components of animal and vegetable tissue. He thought of biochemistry as a tracing out of the chemical events of the living cell, and a relating of these events to function and ultimately to growth itself. All his papers bear the impress of this idea, and to-day it is the accepted meaning of biochemistry. This change-over from the static to the dynamic is largely his work. Not only in his papers, but even more in his lectures and in his discussions over the work of his pupils, this idea was ever uppermost, and if it were possible to measure his influence on the progress of science, his direction of the thought of his pupils and colleagues into these channels would surely be his greatest achievement.

Yet vigorously as Sir Frederick pursued his endeavours to describe the chemical occurrences of the living cell, his point of view was the reverse of vitalistic. Instead of regarding the biochemist as one occupied solely with isolating and analysing, leaving growth and function outside the scope of his investigation, Hopkins had a faith that the chemical changes accompanying and controlling living functions are discernible, and that to devise methods for such studies is the prime duty of the biochemist. It

is perhaps scarcely surprising that there grew up around him a school largely devoted to enzyme chemistry in many varied aspects—the machinery of the cell. The extent to which Sir Frederick's view of the scope of biochemistry is now accepted is the measure of his work, but it is only those who have been privileged to study under his influence in the years during which he has directed his school who can appreciate fully what the subject owes to him. His influence on those who worked with him, even for a short time, was always remarkable. He had the precious gift of illuminating discussions. This was especially evident during 'tea club' meetings of the Department, at which papers were read describing work in progress. Sometimes the audience listened to work which appeared dull and even unimportant, but as soon as the Professor opened the discussion the scene changed, the scattered threads made a pattern and the implication of the work took on a new value. In the experience of his pupils this gift is unique. To be associated with Sir Frederick has resulted for many in a certain liberation of the mind which enabled them then and later to approach problems with a new confidence, problems which, but for him, they would have discarded. Many lesser men freeze and inhibit; he thaws and liberates.

The Gas Research Board

Dr. James Grieve King, superintendent of the Fuel Research Station, East Greenwich, has been appointed director of the Gas Research Board. Dr. King, who is fifty-one years of age, is a native of Scotland, where he started his career as assistant to Prof. T. Gray at the Royal Technical College, Glasgow, during 1912–1914. During the War of 1914–1918, he was chemist and finally departmental superintendent of Nobel's Explosives Co., Ltd. Dr. King joined the staff of the Fuel Research Station as research chemist in 1919, becoming chief chemist in 1920 and superintendent in 1941. He has a very wide experience in the field of fuel technology. The long list of his published researches includes a number of papers presented, either alone or in collaboration, at autumn research meetings of the Institution of Gas Engineers. His joint paper with the late Eng.-Captain J. F. Shaw, on "Recent Experiments at the Fuel Research Station upon Production of Solid Smokeless Fuel", was awarded the Institution Gold Medal for 1934, and his joint paper with Mr. James Jamieson, on "Products obtained by the Carbonization of Scottish Cannel in Continuous Vertical Retorts", was awarded the H. E. Jones London Medal of the Institution in 1936. Among his earliest publications was a joint paper, with Prof. T. Gray, on "The Assay of Coal for Carbonization Purposes", which described the now classic Gray-King apparatus.

Dr. Frederick James Dent has been appointed joint assistant director of the Board. Dr. Dent is thirty-seven years of age and is a native of Leeds. He obtained the B.Sc. degree in gas engineering at the University of Leeds in 1926, the Ph.D. degree in 1929, and was awarded the D.Sc. degree in 1939. He won the Arthur Smithells Research Scholarship and the Le Blanc Medal in 1927, and was the Institution Gas Research Fellow for 1927–1929. Since 1929 he has been a research chemist of the Institution of Gas Engineers and more recently of the Gas Research Board, engaged upon investigations for the Joint Research Committee. Dr. Dent has also given special lectures on water gas manufacture in the University of Leeds.

Newton's Library

Messrs. Henry Sotheran, Ltd., of Sackville Street, W.1, are offering for sale the hitherto undispersed portion of Newton's library. The collection includes several books of great personal and historical interest in connexion with their former owner, the most important being copies of the first and second editions of the "Principia" and Isaac Barrow's edition of Euclid. According to the vendor's notice of the sale, the first two contain a number of corrections, cancellations and additions in Newton's handwriting. These copies formed the basis of the new editions and, judging from the fact that the title page of the copy of the first edition was revised, it seems possible that this copy was intended for the printer. The edition of Barrow's "Euclidis Elementa" contains MS. notes in Newton's handwriting, mostly giving the propositions in algebraic notation. Books V, VI and X received his special attention. It seems likely that this copy was actually used by Newton in his undergraduate days at Trinity College, Cambridge, when he had come to appreciate Euclid. Other items of interest include a copy of the second English translation of Euclid—that made by Captain Rudd, engineer-in-chief to the Royalist forces, published in 1651. It may be the copy of which Brewster states that Newton "threw it aside as a 'trifling book' ". There are also copies of Barrow's "Lectiones Opticæ" (1669) and Huygen's "Traité de la Lumière" (1690), each of which contains an inscription by Newton stating that it was a presentation copy from the author. It is well known that Newton corrected the proofs of the former and made several corrections and additions. It is a surprising and unexplained fact that although Newton by this time was almost certainly in possession of his theory of colours, he did not correct Barrow's ideas on the subject.

The books are offered for sale in two lots, one of them consisting of Barrow's "Euclidis Elementa" and the other of 858 items. It is to be hoped that this interesting collection will be disposed of as a whole and that it will remain in Great Britain. It represents all that is left of the 1,896 books which formed Newton's library when he died in 1727. The complete library was then purchased for £300 by John Huggins, warden of the Fleet Prison, a near neighbour of Newton's. Huggins' receipt for the £300 and a complete list of the books is now in the British Museum. He presented them to his son, who pasted his bookplate, bearing the inscription "Revd. Carol. Huggins, Rector of Chinner, in Com. Oxon.", in all his books. They were afterwards sold for £400 to Dr. James Musgrave, who succeeded Charles Huggins at Chinnor. He pasted his bookplate over that of Charles Huggins, his plate bearing the Musgrave arms and the motto "Philosophemur". The books then disappeared for about 170 years until bundles of them, including one of 200, were sold at rubbish prices at the sale of Thame Park (belonging to the Musgrave family) in 1920. Barrow's Euclid was one of the items disposed of on this occasion. It is these books which are occasionally found in the second-hand bookshops, though many have gone to the United States and, it is feared, many have been treated as waste paper.

The remainder of the library was discovered in 1928 at Barnsley Park (which also belongs to the Musgrave family) by Col. de Villamil, to whose industry and perseverance we owe the unravelling of the mystery of Newton's library. He also discovered at Somerset House a complete inventory of Newton's

possessions at the time of his death. This "true and perfect Inventary" is on vellum and is about five inches broad and seventeen feet long. The skins, about thirty inches long, bear, each, a blue sixpenny stamp, and they are all sewn together. From this inventory we learn that Newton "left 362 books in Folio, 477 in Quarto, 1,057 in Octavo, duodecimo and 24 mo., together with above one hundred weight of pamphlets and wast books". The total of volumes was thus 1,896. These were, we read, in six bookcases and were valued at £270. The lot of 858 volumes is offered for £5,000 and the copy of Barrow's Euclid for £500. Further particulars may be obtained from the vendors.

Newton and Alchemy

NEWTON has been regarded by a number of writers as a credulous alchemist. In some notes on Newton's chemical philosophy written upon the occasion of the tercentenary of his birth, Dr. D. McKie (*Phil. Mag.*, 33, 847; 1942) disputes this judgment. Newton's interest in chemistry probably began when he was lodging with Clark, the Grantham apothecary, while attending the King's School. He noted down interesting chemical recipes in his earliest note-books when he had a highly practical mind and great skill with his hands. Later on, in 1665 and in 1669, we have records that he bought chemical apparatus and materials. At this time, too, he experimented on the production of alloys that would take a high polish and would therefore be suitable for use as mirrors in the reflecting telescope that he had recently designed. In considering whether Newton should be regarded as a chemist or as an alchemist, Dr. McKie examines Newton's own chemical writings, from which "it would be difficult to conclude that he was 'a credulous alchemist'. Rather, he appears as a pioneer in the study of chemical attraction, as in fact he appeared to many of those who came immediately after him and who held his 'Queries' in such high regard during the eighteenth century". As distinct from his own chemical writings, Newton copied out many long passages and made very extensive extracts from a large number of alchemical writings. Dr. McKie claims that too much significance has been put upon these extracts. Many of them were from rare books, and many alchemical books gave useful information on the properties of the metals and their compounds. Moreover, Newton copied out passages from books that were not alchemical. "We might also ask what man of science would care to be judged by what he had copied out of books." Newton's chemical thought set forth in his published writings shows an advance towards modern chemistry rather than a reversion to the already discredited pursuit of gold-making.

Historical Method in Teaching Science

PROF. J. KENNER, of the Manchester College of Technology, recently opened a discussion on the "Historical Method in Teaching Science" at a meeting of the Manchester Literary and Philosophical Society. Bearing in mind the need to produce able rather than merely learned men, Prof. Kenner examined the matter, first from the wider point of view of the problem of general education, and quoted from recent articles indicating failures caused by "inadequacy of outlook, a whole method of approach" and by lack of a creative and forward-looking spirit. If those failures are to be avoided in the future, he urged close examination of our educational scheme. If education be defined as deliberate adjustment to environment, he insisted that "if this environment is to be healthy, it must be progressive". Put more fully, his view was that education "should be conceived and designed as a training for life in a progressive environment", and each should contribute to its progress according to his ability. Prof. Kenner recommended that natural science should be taught as a record of progress and of the methods by which that progress has been achieved. Separate courses on the history of science are not necessary. It should be an integral part of teaching. Appreciation of science, its discipline, its procedure and its possibilities are not only useful intrinsically "but also as a criterion of proposed public policy in regard to it". One of the main difficulties in the War, Prof. Kenner pointed out, lies in the present examination requirements.

Reconstruction Problems in School and Home

AN interim report has just been issued by the Electrical Association for Women giving the Association's point of view on post-war reconstruction as affecting education and careers, housing and kitchen planning, and electricity in the home, coupled with the design and performance of electrical apparatus and appliances. So far as education and careers are concerned, it is considered that school buildings must be designed for many age-groups, they should show a high æsthetic standard of design, be of high-grade materials, and pay proper attention to health and comfort. The school should be the centre of juvenile life and a meeting-place for parents and teachers. Greater consideration should be given to domestic subjects both for girls and boys, so that domestic science shall take its rightful place, providing training for new careers in the post-war world and a basis for citizenship. As regards housing and kitchen planning, homes should be designed to meet the varying requirements of different types of occupants—families, single persons, the aged, etc. Public services such as electricity, main water and drainage, and telephones should be universally available.

In the sphere of electrical equipment, it is pointed out that electricity as a source of domestic power is increasingly popular with housewives who want efficiency and economy. Standardization of voltage, current, apparatus, and accessories such as plugs, sockets, switches, connectors is desired. Table-type cookers and refrigerators should generally be installed in order to avoid stooping. Every newly built home should have its built-in refrigerating unit. Good kitchen lighting is imperative. Women want efficiency instead of 'ornamentation'; they are even prepared to forgo variety if good design and performance is within the reach of all. These are the salient features in the report, collated by Elsie E. Edwards, which is the culmination of two years study by women in all parts of Great Britain.

Livestock Management and Public Health

AT a meeting of the Backs to the Land Club on March 25, the subject of hygiene in connexion with domestic food production was discussed. Prof. J. W. Munro said that scientific men would be willing to tackle any problems that 'backyarders' might be confronted with in the avoidance of public nuisance. Mr. W. McA. Gracie, director of Infestation Control at the Ministry of Food, referred to the problem of rats, and it was agreed that by making knowledge

of their movements available, householders could render greater assistance than by isolated and spasmodic attempts at destruction. Pig keepers and poultry keepers contributed to the discussion by giving their experiences of livestock management in built-up areas, and suggested standards that might be laid down to protect public health and amenities after the War. It was agreed that while a measure of livestock keeping is necessary to maintain soil fertility, the disposal of small amounts of manure presents a difficult problem. Some pig clubs have got over the difficulty by composting. The subjects of food storage and insect pests associated with the different classes of livestock were referred to. The chairman, Mr. John Green, said that at law livestock keeping is permitted anywhere provided it does not amount to a nuisance, but that following a number of cases at the end of the last century, many public authorities had passed by-laws under the Public Health Acts, restricting these enterprises.

Phenology of 1942

With admirable promptitude in these difficult times, the fifty-second annual phenological report of the Royal Meteorological Society has been issued, covering the observations on the weather and fauna and flora in Britain from December 1941 to November 1942. This is interesting because the cold spring included the coldest February in England and Wales since 1895, and the dry period in summer included a thirty-two days drought, the longest for thirteen years. It was an abundant year for crops and wild and cultivated fruits of almost every kind, while grass fields appeared exceptionally green in the autumn and the season was sufficiently free from frosts to produce a wealth of autumn tints, many oaks keeping their foliage in sheltered places into December. Migrant birds were uniformly late in reaching the most northerly zone in spring, but the cuckoo was the only bird to be late in all three zones, the other zones showing first migrant arrivals in advance of the average dates. 1942 was a year of comparative scarcity of immigrant Lepidoptera, especially of the painted lady butterfly, although some localities had considerable arrivals, and three migrant insects, the red admiral butterfly and the silver Y and convolvulus hawk moths, were recorded in the Shetlands.

Two hundred and sixty-four observers sent in their records, a slight reduction on previous years. It is noted that in order to arrive at a high degree of accuracy in average values for plant and insect dates, there should be revisions at intervals of five or ten years; also that weather responses in different districts must be analysed separately when the meteorological characteristics of the season differ in those districts. Responses depend on the incidence of the weather in relation to the average dates, so that they are not necessarily uniform. The zone diagrams show that there is less difference in date between groups, as a whole, in different zones, than there is between the dates from observing stations in individual groups: the former may amount to a few days but the latter to a few weeks.

Gifts to Universities of Leeds and Sheffield

A few weeks ago, it was announced that Mr. Henry Ellison had given the University of Leeds £50,000 to create an endowment fund for the provision of post-graduate fellowships for research in pure and applied chemistry and physics (see Nature, March 13, p. 303). He has now put the scientific world further in his debt by a gift of £25,000, spread over seven years, to the University of Sheffield, with the suggestion that the money be expended during the years immediately following the War on a scientific research fellowship. Mr. Ellison, who is chairman of the Yorkshire Tar Distillers, Ltd., and has been associated for many years with the Sheffield Chemical Company and the Mirvale Chemical Company, is an old student of the Yorkshire College, the forerunner of the University of Leeds. His gifts, besides being of direct service to the industries in which he is himself directly interested, form a notable addition to the resources available in Great Britain for scientific research.

Co-operative Systems in European Agriculture

The British Association, through its Division for the Social and International Relations of Science, is arranging a conference on "Co-operative Systems in European Agriculture", to be held on Friday and Saturday, April 16 and 17, at the Royal Institute of International Affairs, Chatham House, St. James's Square, S.W.1, by kind permission of the Institute. The Conference will be opened by Sir Richard Gregory, president of the Association, and there will be four sessions, the subjects of which will be co-operation in three groups of European countries (north, west and east), and immediate relief after the War. Tickets of admission will be obtainable from the British Association, Burlington House, London, W.1.

Announcements

Sir Harold Hartley has been appointed general treasurer of the British Association as from April 1, the beginning of a new financial year. He succeeds Prof. P. G. H. Boswell, who has resigned after twelve years service in office, first as a general secretary (1931–35), and then as general treasurer (1935–43). The gratitude due from the Association to Prof. Boswell has been acknowledged in a resolution by the General Committee.

At the annual general meeting of the Institution of Chemical Engineers, on April 2, the following medals for 1942 were presented: *Osborne Reynolds Medal*, Mr. L. O. Newton; *Moulton Medal*, Mr. W. K. Hutchison and Dr. E. Spivey, for their paper on "Design and Performance of Cooling Towers"; *Junior Moulton Medal and Award*, Dr. S. H. Wade, for his paper on "Evaporation of Liquids in Currents of Air"; *William Macnab Medals*, Mr. J. H. Sharp and Mr. F. J. Wilkins.

The Committee on Africa, the War and Peace Aims has issued as a supplement to "The Atlantic Charter and Africa from an American Standpoint" a compilation by Rev. Dr. E. W. Smith entitled "Events in African History". This is a chronology in two parts, ancient and modern, with an index mainly of references to persons, places and organizations, with some subject entries. The modern chronology which occupies the greater part of the brochure is in three sections covering, respectively, the period of unrestricted slave-trade, 1415–1807; the period of struggle to extirpate slave-trade and slavery; exploration; partition; preliminary economic development; and expansion of Christianity (1807–1918); and the period of trusteeship (1919–1942).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Development of Cold Agglutinins in Atypical Pneumonia

In addition to the classical *iso*-agglutinins that delineate the four primary blood groups of man, there exist in many normal sera other substances which may cause clumping of erythrocytes and are called 'cold' agglutinins because in most instances their action appears at low temperatures only. Specific cold agglutinins, concerned with the sub-groups of type *A* blood, have been distinguished[1]. The cold agglutinins are, however, otherwise considered to be non-specific inasmuch as they will produce clumping of all human red blood cells irrespective of group. Moreover, since they likewise affect the cells of the individual in whose serum they appear, they are sometimes named auto-agglutinins. The reaction is delicate and usually disappears when the serum is diluted beyond 1 : 10. Cold agglutinins of this type have attracted attention from time to time when existing in quantity enough to be manifest even at room temperature and so interfere with the cross-matching of bloods for transfusion. Such occasions are still rare enough to warrant reports of single cases of their occurrence. McCombs and McElroy found in the literature thirty-eight instances[2]. Among these were represented diseases as varied as cirrhosis of the liver, trypanosomiasis and pneumonia. With the exception of paroxysmal hæmoglobinuria, which occupies a unique position, there would seem to be no regularity in the behaviour of cold agglutinins in disease, although it may be pointed out that systematic clinical and serological investigation of the subject has been neglected.

During the past four years two patients have been encountered whose blood serum upon routine testing for transfusion agglutinated the cells of donors of the same group. Both were seriously ill with pneumonia of the variety which has been called in the United States 'atypical' or 'virus type'. The first case (*J.C.T.*) was not studied further, but in the second (*F*) it was found that the acute phase of the disease was associated with the presence of cold agglutinin in the titre 1 : 2,000. Entertaining the hypothesis that cold agglutinins in smaller yet measurably abnormal amounts might occur in other, less severe examples of atypical pneumonia, a quantitative titration of the cold agglutinin content of the blood serum has been carried out in 22 cases. The findings are herewith presented.

The serological method employed was the customary one using 0·2 ml. of serum serially diluted in small test tubes. (After the blood was withdrawn from the subjects it was kept at a temperature as near 37° as possible until the serum was separated.) 0·1 ml. of 2 per cent suspension of washed group *O* human erythrocytes was added to each tube, the racks set in the refrigerator and readings made the following morning. The results may be seen in the accompanying table.

Note should be made not only of the obvious quantitative differences in titre, but also that no less than 10 pneumonia sera produced a hard, solid disk of agglutinated cells. This is in sharp contrast to the delicate clumping usually seen in the controls, none of which showed a disk.

The controls represented a number of infections, including pyelitis, osteomyelitis, empyœma, hæmolytic streptococcus sore throat, and 'grippe'. In this group are included also five examples of pneumococcus infection in which the organism was isolated from the sputum and in which there occurred a prompt and sharp recovery following administration of sulphadiazine.

The label 'atypical' pneumonia is given for want of a better. The epidemic proportions assumed by this disease during the past few years both in the civilian and military populations of the United States have given it an important place among respiratory diseases in the mind of the American physician. All of the cases in this group were thought by the clinicians to have atypical pneumonia, although not all were acutely ill when the test was performed. However, some of them may well have been pneumococcal, and nothing could be clearer than the necessity for a thoroughgoing bacteriological study, joined with the titration of cold agglutinins, in a much larger number of cases. In many of the patients reported upon here, all of whom were soldiers in the oversea forces of the U.S. Army, bacteriological investigation beyond that required for immediate clinical treatment was often difficult. A more comprehensive attack upon the problem is being undertaken. Meanwhile, on the basis of findings in several examples of definite instances of atypical, non-pneumococcal pneumonia, it would appear likely that the titre of cold agglutinins in the serum rises during the acute period of this disease, in contrast both to the convalescent phase and to pneumococcus pneumonia.

In this respect it is of much interest that one of the first clinical contributions to the subject of auto-agglutination consisted in a description of the rise and fall in titre of cold agglutinins in the blood of a patient who had prolonged and rather unusual pneumonia. Pneumococci were not found in the sputum : the illness lasted some four weeks[3]. More recently, two not dissimilar cases have been noted[4]. If to these are added the two instances commented upon earlier in the present communication, pneumonia is seen to be responsible for an appreciable number of the recorded occurrences of cold agglutinin in amount sufficient to interfere with cross-matching of blood. Quantitative serological studies, together with proper bacteriological examinations, should

NUMBER SHOWING TITRE OF:

	Total number	1 : 2 or less	1 : 4	1 : 8	1 : 16	1 : 32	1 : 64	1 : 128	1 : 256 or more
Atypical pneumonia	22	5	1	3	1	2	3	5	2
Controls	29	17	5	6	1	0	0	0	0

clarify the relation of pneumonia to the cold agglutinins, and indicate furthermore whether this type of agglutinin is, in fact, non-specific.

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March 12.

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[2] McCombs, R. P., and McElroy, J. S., *Arch. Int. Med.*, **59**, 107 (1937).
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'Condensation' in Fermi-Dirac Statistics

RECENTLY London[1], Tisza[2] and others have studied in detail the peculiar condensation phenomena for a Bose-Einstein gas because of its possible application to liquid helium II. As is well known, the condensed phase occurs in a Bose-Einstein gas when for a given temperature T and volume V, the number (N) of particles exceeds the value N^* given by neglecting the effect of relativistic mechanics,

$$N^* = Vg\left(\frac{2\pi mkT}{h^2}\right)^{3/2}\zeta(\tfrac{3}{2}), \quad \zeta(\tfrac{3}{2}) = 2{\cdot}61,$$

where m is the mass of a particle, g its weight factor by virtue of its internal structure, and the other symbols have their usual meaning. The condensed phase is populated by $(N - N^*)$ particles lying in the zero energy state. In this note the possible existence of a condensed phase for a Fermi-Dirac gas is discussed.

Born[3] in a recent paper has shown that according to the reciprocity principle the number $a(p)dp$ of wave-functions of a particle, the momentum of which lies within the range p and $p + dp$, is given by

$$a(p)dp = \frac{4\pi Vg}{h^3}\frac{p^2\,dp}{(1-p^2/b^2)^{1/2}}, \quad . \quad . \quad (1)$$

where b is the maximum value possible for momentum, that is, b is the upper limit of p. The total number of wave-functions (a_0) possible, therefore, in a region of volume V is (according to Born),

$$a_0 = \int_0^b a(p)dp = \frac{g\pi Vb^3}{h^3}. \quad . \quad . \quad (2)$$

As in the case of a Fermi-Dirac gas any independent wave-function cannot accommodate more than one particle, equation (2) imposes an upper limit ($N \equiv N_0 = a_0$) on the number of particles that can be contained in volume V.

What happens when the number of particles N introduced in the given volume exceeds N_0? To answer this question we revert to (2). In replacing the sum of all possible eigen-states extending from ($p = 0$) to ($p = b$) by the integral in (2), the total number of eigen-states has become limited though it is in reality infinite, for the number of eigen-states corresponding to $p \to b$ is infinite. The total number a of states is

$$a = a_0 + a_1,$$

where a_1 denotes the infinitely large number of states corresponding to $p \to b$. It follows, therefore, that when the number of particles N present in the assembly exceeds N_0, a *condensed* phase containing $(N - N_0)$ particles will be formed, all the particles in the condensed phase possessing the momentum b.

In the case of a Bose-Einstein gas the condensed phase is formed by particles in the zero energy state, whereas for a Fermi-Dirac gas the condensed phase (its existence depending upon Born's reciprocity theory) is formed by particles in the highest energy state corresponding to $p = b$.

This condensed phase will obviously be significant for astrophysical applications of the reciprocity theory, but these will not be considered here.

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Frictional Properties of Metallic Films

EXPERIMENTS, to be described elsewhere, in which the electromotive force generated by a loaded rotating steel ball in frictional contact with a metal block was measured, showed that the steel ball tended to pick up metal from the flat surface, and that metallic films wiped out on metal surfaces by hand affected both the magnitude of the electromotive force and the size of the final wear impression. Films of tin, copper, lead and zinc wiped out on Timken test blocks reduced the electromotive force in this order of merit when no oil had been applied to the contact. On the other hand, a film of tin rubbed on to the flat surface of a hardened steel roller led to an increase in both the electromotive force and the diameter of the final wear impression, and a film of lead rubbed on to a block of copper had a similar effect.

Even in those cases in which the films reduce the electromotive force under 'dry' conditions, they do not appear to function as a lubricant for a brief interval until normal lubricating conditions are re-established, as has been suggested on the ground of experiments with the Bowden-Leben apparatus[1]. Of the four metallic films, the film of lead was the only one to reduce the electromotive force appreciably and to delay transition to tearing in the presence of a straight mineral oil. With an extreme-pressure addition, such as 2 per cent of chlorinated paraffin-wax, the metallic films cause an increase in the electromotive force in the order 'no film', lead, tin, copper, in which they promote corrosion.

These results are essentially different from those reported with the Bowden-Leben apparatus[1,2], which has the peculiarity that a hemisphere is made to plough a groove on a flat surface. The resistance to ploughing depends upon the shear strength of the portion of the metal which is to be ploughed up, and decreases as *one* groove is being worn in. Thus, the decrease in the resistance to ploughing found with a lead-copper alloy in the course of fifty strokes in the same track and at the same load does appear to be the trend which can be expected with any metal that is softer than the hemisphere, and it does not prove that "in a heterogeneous bearing metal the soft phase wipes out over the hard phase during sliding". The view that the ploughing action is the essential feature of the Bowden-Leben apparatus when the hemisphere is the harder of the two

friction elements finds support in Bowden and Tabor's observation that for any given *track-width* the friction is the same on bulk indium as it is on indium films on a steel substrate.

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March 8.

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Magnitudes of Lightning Currents

THE magnitudes of the total peak currents in lightning flashes have been over-estimated hitherto, due to the assumption made as to the relationship between the peak currents in individual discharge paths and the total peak current in any one flash.

Several methods have been used to determine the magnitudes of the current in lightning discharges to earth[1]. Most of these methods involve a knowledge of one or more parameters of the lightning flash, such as its length and the velocity of the return stroke, or the shape and the duration of the current wave. Direct measurement of the current amplitudes became possible by the installation of magnetic links which indicate the peak value of the current discharged through a metallic earthed conductor on which they are mounted. During the last ten years, more than a thousand lightning flashes to transmission lines with earth wires have been investigated by means of magnetic links in various parts of the world, and frequency-distribution curves of current magnitudes have been given.

The method which has so far been universally used for obtaining the total current in the lightning channel is based on the assumption that the currents in the various paths to earth are in phase, that is, that the current peaks occur simultaneously in the tower struck and in the adjacent earth wire. The total lightning current was then obtained by adding the crest values of the individual currents. In cases where magnetic links have not been installed on the earth wire, the total current has been taken as the sum of the currents in all the towers affected, thus tacitly assuming that the peak values even of currents in adjacent towers occur simultaneously.

I have now evolved a new method of calculation which is based on a quasi-stationary determination of the distribution of a lightning current in the various parts of a transmission system on the assumption of an average double exponential current wave. Calculations, which will be reported more fully at a later date, show that the crest of the current which is discharged through the tower struck occurs during the front of the total lightning current wave, whereas the crest values of the currents in the earth wire and therefore in the neighbouring towers occur always during the period corresponding to the tail of the total current wave. The phase differences between the component currents vary with the geometrical dimensions of the transmission lines and increase rapidly with decreasing tower footing resistances. It therefore follows that lightning currents calculated according to the old method are too high, and it can be shown that the resulting percentage error increases rapidly with increasing tower footing resistance up to a maximum of 40–50 per cent; this maximum occurs within the most common resistance range, that is, between 10 and 20 ohms, after which the error decreases very slowly for higher resistance values. It can thus be seen that the maximum and average current values, so far accepted as being approximately 220 kiloamp. and 20 kiloamp., respectively, can now be taken to be of the order of 160 kiloamp. and 15 kiloamp. respectively.

Several investigators[2] have recently obtained magnetic-link records on single lightning conductors and have commented on the smaller crest values compared with those formerly accepted. The new theory provides an explanation, and it is interesting to note that, though the number of observations is too small to form the basis for a new distribution curve, the current magnitudes fall within the range now suggested.

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[1] Bruce, C. E. R., and Golde, R. H., *J. Inst. Elec. Eng.*, **88**, Part II, 487 (1941).
[2] Wagner, C. F., and McCann, G. D., *Elec. Eng.*, **60**, 483 (1941). Gross, I. W., and Lippert, G. D., *Trans. Amer. Inst. Elec. Eng.*, **61**, 178 (1942).

Potatoes and War Economy

IN connexion with Prof. Lysenko's communication to Sir John Russell on some unorthodox emergency methods of potato propagation[1] the following observations may be both relevant and complementary.

Since 1937, Mr. Alexander McI. Cleland of 'Macedon', Green Road, Knock, Belfast, has been carrying out experiments on the cultivation of potatoes (Albert Victor purple variety) from tuber *cuttings*, as well as *peelings*. The experimental plot had a light loam soil based on glacial sand, and was divided into beds 4 ft. in width, which received no treatment, apart from turning over and occasional weeding. Early in spring, tuber cuttings, each containing an 'eye' attached to a piece of potato (about ¼ in. in diameter and ½ oz. in weight) were planted in shallow boxes; towards the end of May the sproutings were re-set in the plot 9 in. apart. At the end of the season, 288 'eyes' from 24 lb. of potatoes yielded 804 tubers weighing 172 lb., in addition to a large number of seed potatoes.

In the case of peelings, as represented by freshly collected kitchen waste, they were broadcast (avoiding overlapping) on to a garden bed and lightly covered with soil, the operation being carried out at regular intervals between the beginning of May and mid-June. The plantings readily sprouted, yielding at the end of the season 32 lb. of usable potatoes, as well as many seed potatoes. The crops were free from disease (in agreement with the Russian observations) and of good quality.

This great difference in yield scarcely represents, however, the relative merit of the two methods of propagation. Apart from the 'eyes', made defective prior and during the peeling, the time and manner of planting puts the peeling procedure at a disadvantage which could no doubt be rectified by improved co-ordination. Again, although the yields recorded here are below those attainable under intensive or even normal conditions of cultivation, they have the redeeming feature of constituting an *additional* crop. Thus in cases where the land and

labour problem is dominated by the need to conserve existing stocks of potatoes, as in the U.S.S.R. now, such emergency methods of propagation may be justified in practice. The trade in certified seed "potato-eyes" fostered in North America[2] and the sporadic, small-scale cultivation of potatoes from detached sprouts or tuber cuttings in Great Britain[3] add local colour and emphasis to the vast agricultural efforts now being made in the U.S.S.R.

As regards the acceleration of seed potato sprouting (loc. cit.[1]), the mechanical removal of the protecting skin could perhaps be substituted by such treatment as oxidation with potassium permanganate, or dissolution of the outer covering with cuprammonium sulphate, followed if necessary by contact with organo-mercury compounds, effected by a conveyor belt dipper[4].

145 Alexandra Road, Manchester, 16. MAURICE COPISAROW.

[1] NATURE, 150, 486 (1942); 151, 77 (1943).
[2] *Amer. Potato J.*, 14, 23 (1937).
[3] Polunin, *Gard. Chron.*, January 23 (1943).
[4] Wakely and Mellor, NATURE, 150, 769 (1942).

Physiology of Colour Vision

THE article by E. N. Willmer in NATURE of February 20 is interesting, but there is no evidence that the rods are percipient elements; rather there is overwhelming evidence that they are nerve elements sensitizing the film round the cones with the visual purple. The displacement of the positive after-image proves conclusively that the primary stimulus in vision is liquid, the muscles of the eye having a double function, one to move the eye, and the other by pressing on the back of the eye and shifting the photochemical film in the direction in which the eye is moved. The negative after-image remains in its primary position, but the positive after-image is seen farther on in the direction in which the eye is moved. This can easily be seen with a light, or even with an area of colour on a white ground. If, for example, a red square on a white ground be looked at for as short a time as possible and then the eyes be directed at a point immediately above the square, a green negative after-image will be seen at this point and higher up a distorted positive after-image or a series of red dots on a light red ground exactly similar to the cones of the retina viewed under a high-power microscope. There is no persistence of vision in ordinary circumstances when the eye is moved, but when the hand is moved in front of the eyes a dozen or more hands will be seen.

F. W. EDRIDGE-GREEN.
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MR. E. N. WILLMER has proposed an interesting hypothesis of colour vision[1]. It is not possible in the length of this letter to cover all the points that Mr. Willmer has raised. I will limit myself to two only, namely, colour mixture and adaptation.

According to Mr. Willmer's hypothesis, the parts of the spectrum lying between the red and the violet are perceived by stimulation of the rod and the cone elements in certain fixed ratios; whereas the red end of the spectrum stimulates the cones only, the violet end of the spectrum stimulates the rods only. According to this hypothesis, it should therefore be possible to match all the colours of the spectrum in turn by suitable mixtures of red and violet rays. Experiment demonstrates conclusively, however, that such mixtures yield crimsons and purples; so that in this case hypothesis and experiment are apparently at variance.

I should expect, from Mr. Willmer's hypothesis, that exposure of the eyes to violet rays would depress for a time the sensitivity of the rod retinal perceptors. If then, immediately after such an exposure, the eye be directed at a white surface, one would expect this to appear tinted with red for a short time, due to the temporary predominance of the cone receptors. Experiment, however, shows that the white surface is tinted not with red but with yellow; so hypothesis and experiment apparently do not agree. On exposure of the eye to red rays, according to Mr. Willmer's hypothesis, the white surface, for similar reasons, should appear to have a violet tint. Experiment, however, shows that the tinting is greenish-blue, so that again hypothesis and experiment apparently do not agree.

If there was a dearth of theories on colour vision, Mr. Willmer's hypothesis would be acceptable even if it did not fit in with all the observed facts, because any theory is of value which acts as a stimulus for further research. But there are endless theories of colour vision, many of which, after a short life, have met with a deserved and unregretted end. I hope Mr. Willmer will clear up the apparent divergencies I have pointed out above between what seem to me to be conclusions from his theory and the experimental facts.

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[1] NATURE, 151, 213 (1943).

Minimum Human Requirements and the Beveridge Report

IT is a matter for satisfaction that Sir William Beveridge has, in his report, recognized the principle that quantitative standards based on scientific knowledge may, and should, be applied to the measurement of minimum human requirements in food, fuel, light and clothing. As medical knowledge advances, and as cultural demands change, any standards of this nature will be gradually modified, though there can be no doubt that those for food have now been determined with a fair degree of scientific accuracy. We would express our conviction that the food standards now proposed for Great Britain, based as they are on the scales laid down by the British Medical Association and the League of Nations Technical Commission, accord with the opinion of all accredited scientific workers in this particular field.

It is not our business to decide what shall be the actual scales of cash benefit and allowance under any system of social security. That decision rests with the people of Great Britain and with their elected representatives. But we do urge that all such scales shall, in future, be related immediately to the scientifically estimated needs of each type of beneficiary.

JOSEPH BARCROFT.	CHARLES MARTIN.
STANLEY DAVIDSON.	R. MCCARRISON.
F. GOWLAND HOPKINS.	MORAN OF MANTON.
HORDER.	B. S. ROWNTREE.
JULIAN HUXLEY.	J. C. SPENCE.
J. M. MACKINTOSH.	W. H. WYNN.

LAW OF THE MOVING-IRON ELECTRICAL INSTRUMENT

THE law of the moving-iron instrument has been given in the form, torque equals $\frac{1}{2}I^2dL/d\theta$, where I is the current in the coil and $dL/d\theta$ the rate of change of inductance with angular deflexion. This law assumes the current remains constant for a small change in deflexion, but since a change in inductance is produced by a change in current, the assumption does not seem justifiable. The law therefore takes a more complicated form, and in a paper on the subject (*J. Inst. Elec. Eng.*, 90, Pt. II, No. 13, February 1943) Dr. G. F. Tagg describes experiments which show that the simple law does not hold for a simple electromagnetic system, and it is considered that the law as enunciated in most text-books is incorrect.

Moving-iron instruments do not generally lend themselves to any simple theoretical treatment, and the very nature of the instrument makes any calculation of the current-torque relation very difficult, if not impossible. It is stated in the proof of text-book equations governing the law that the energy of the coil is $\frac{1}{2}LI^2$ and that it is a change in this energy which produces the pull. The pull is exerted on the iron, and there is no justification for assuming that the whole of the magnetic energy is used to produce it. It is the magnetic potential of the iron which matters, and this is not necessarily the same as that of the coil. Again, the statement is made "if the current remains constant"; but this cannot apply as a change in current produces a change in deflexion, and it is not possible to have an effect and to assume that the cause is zero.

It is suggested that the true equations are, in the case of an angular deflection θ, the torque

$$T = \frac{d(\frac{1}{2}\eta LI^2)}{d\theta} = \frac{1}{2}\eta I^2\frac{dL}{d\theta} + \frac{1}{2}I^2L\frac{d\eta}{d\theta} + LI\eta\frac{dI}{d\theta},$$

and that for a linear deflexion x, the pull

$$F = \frac{d(\frac{1}{2}\eta LI^2)}{dx} = \frac{1}{2}\eta I^2\frac{dL}{dx} + \frac{1}{2}I^2L\frac{d\eta}{dx} + LI\eta\frac{dI}{dx},$$

in which η represents the magnetic efficiency. The available energy to produce torque or force is $\frac{1}{2}\eta LI^2$; η, L and I can all be regarded as functions of x.

The true expression for the torque or pull is thus more complicated than the simple ones usually put forward and involves a quantity η, the 'magnetic efficiency', the value of which it is practically impossible to predetermine. It is therefore a matter of extreme difficulty to forecast the behaviour of any particular instrument, and experiment appears to be the only solution.

Dr. C. V. Drysdale, dealing with the "Torque of Soft-Iron Electrical Instruments" (*J. Inst. Elec. Eng.*, 90, Pt. II, No. 13, February 1943) shows that the inductance formulæ $F = \frac{1}{2}I^2\partial L/\partial x$ and $T = \frac{1}{2}I^2\partial L/\partial\theta$ are correct for iron-cored instruments if the magnetization of the iron does not exceed the maximum value permissible for accurate indication. For higher magnetizations the force or torque is higher than the value given by the formulæ, and becomes twice as great when the iron approaches saturation.

The inductance method of calculating the torque of electromagnetic instruments is so valuable, both for design purposes and for the experimental shaping of the moving iron without the laborious process of dismantling, rebalancing and reassembling the movement for each modification, that it has now been fairly widely adopted. The experiments carried out by Dr. Tagg referred to above have led him to claim, however, that the method is based on unjustifiable assumptions and has no experimental confirmation; it is true that it is applicable only when the magnetization of the iron does not exceed a certain value; but this limitation does not affect its utility for the development of accurate instruments.

In view of the above claim and of the importance and limitation of the method, it is desirable that its theory should be completed, established and extended. It is based on the principle of the conservation of energy, and is so closely analogous for electrostatic and electromagnetic instruments that it is advantageous to consider them together; this is done in the paper referred to. It is shown that the formulæ already mentioned are applicable to soft-iron instruments if the magnetic flux on the iron is proportional to the current. For electrostatic instruments the capacitance is independent of the potential difference, so that the formulæ $f = \frac{1}{2}V^2\partial C/\partial x$ and $T = \frac{1}{2}V^2\partial C/\partial\theta$ are always valid. The paper also discusses the effect of variable permeability of the iron circuit of electromagnetic instruments.

PRESERVATION OF TIMBER IN RHODESIA

R. H. FINLAY, forest officer, Department of Agriculture, Rhodesia, has discussed the preservation of timber in that country (*Proc. Rhodesia Sci. Assoc.*, 39, 103; 1942). After dealing with some of the earliest methods of utilizing durable timbers, Mr. Finlay comes to the period when, with the greater utilization by man of varying timbers from the forests and the consequent necessity for extending the period of utility of the softer woods, attempts were made to introduce preservative treatment. Mercuric chloride and copper sulphate had already been recommended in the eighteenth century, but methods of treatment with these were not patented until the 1830's. In 1832 Kyan patented a method based on mercuric chloride or corrosive sublimate, which came to be known as 'kyanizing'. Sir William Burnett then made use of zinc chloride, and the method was patented in 1838. Originally this consisted in immersing the timber in open tanks of zinc chloride; the method is still used. Later it was modified to a pressure process known as 'burnettizing'. Creosote, even more familiar to-day on the countryside in England, was also experimented with at this time, and in 1838 John Bethell was granted a patent to inject creosote under pressure. The modern Bethell or full-cell process is the direct outcome of this process. As is well known, attention became more and more fixed on the use of creosotes and mixtures containing it, and they hold high rank to-day.

In recent years the market has had a sequence of proprietary preservatives, but for the most part they cannot be said to be truly established as commercial timber preservatives. Moreover, as Mr. Finlay goes on to show, different climatic conditions affect very considerably the methods which it may be possible to introduce. For example, protection against the termite may vary in dry hot as against moist hot localities. Further, there are innumerable borer and fungus attacks to be considered, including the marine borer. An interesting example of present knowledge on the subject is connected with a fungus growth

known as 'blue stain'. Some timbers, and perhaps specially the softer types of broadleaved trees, when freshly cut from the green log, grow a fungus within a few days which gives a blue colour to the timber. The stain, as a matter of fact, has no effect on the soundness or durability of the wood, but it has not proved possible to convince the purchaser of this, and thus the price is either seriously affected or the wood becomes unsalable, and this within a very short time. Research has resulted in a cheap bath or spray becoming available with which the wood is treated before the fungus appears. In Rhodesia the spray known as 'dowicide P.', composed of a mixture of sodium tetrachlorophenoxide and sodium di-chloro-ortho-phenyl-phenoxide, is used. Since some of the tropical forest areas within the British Empire contain considerable amounts of soft-wooded hardwoods, which, if they can be marketed, would save the imports of coniferous timber at considerable cost which was so common up to 1939, the discovery of this treatment should be of assistance to various forestry departments. The author gives in his paper details of the methods of applying preservatives.

The question of imports of timbers, mostly coniferous soft woods, into Colonies which possess a certain or considerable area of forests, is considered by Mr. Finlay in a second paper published in the same journal (*Proc. Rhodesia Sci. Assoc.*, **39**, 88; 1942) under the title "Post-War Employment and the Timber Industry". In so far as timber products are concerned, any new industry would have an indirect subsidy for a number of years through lack of shipping space and the enormous demand on the forests of the world which the vast repairs to damaged cities and houses on the countrysides will entail. Rhodesia from its geographical position will have to be self-dependent, he considers, at any rate in soft woods. He considers this should be feasible though he makes an interesting remark on the subject of these timber imports; the first of these are "Oak and Teak, woods of such universal popularity that there is little or no hope of their ever being eliminated from the list of imports". Yet there are those in Britain who consider the valuable hardwoods no longer worth growing.

GAMMA-RADIOGRAPHY

A PAPER on gamma-radiography was read by Mr. C. Croxson at a meeting of the Industrial Radiology Group of the Institute of Physics, held at Loughborough College, Loughborough, on February 27. Mr. Croxson explained that gamma-radiography is complementary to radiography by X-rays, the chief advantages of radiography by a gamma-ray source being due to the high penetration of gamma-rays and to the fact that a source of gamma-rays is relatively small and can therefore be used in locations quite inaccessible to an X-ray equipment. In the past, sources of up to about 250 mgm. of radium element have been used, but recent work has shown that radon (radium emanation) sources are superior for some work since, for the same source size, radon has an initial intensity sixty or seventy times greater than that of radium: with the smaller source sizes thus obtainable, source-film distances of as low as three inches become practical without serious loss in definition. The main disadvantage lies in the short half-life period of radon of about 3·85 days compared with 1,590 years for radium, but since the decay-rate is known, exposures can be readily calculated from exposure curves worked out for radium sources of known intensity. As a war-time measure, the radium is transported in a steel container, three inches thick. For use, the gamma-ray source is transferred to an exposure bomb which has an aperture for the emerging beam, the container being carefully designed to avoid scattered radiation marring any radiograph made.

In making a radiograph, the gamma-ray source is carefully positioned on one side of the specimen and the photographic film is placed on the side of the specimen remote from the source, the object-film distance being kept as small as possible to reduce geometric unsharpness and image distortion. Ordinary X-ray films are used for the work. Where maximum speed is essential despite unsharpness, calcium tungstate intensifying screens should be used with the so-called screen-type X-ray films. Somewhat lower speed but better definition is obtained by exposing the film between lead intensifying screens: in these circumstances the direct or 'non-screen' X-ray films give maximum contrast, but 'screen-type' films may be used at the expense of some slight loss in contrast. Compensation for the lower speed may be achieved by exposing two films simultaneously in a lead-screen/film/lead-screen/film/lead-screen pack: alternatively, the same technique may be used to obtain two copies of the radiograph at one exposure. Over-development, up to ten minutes, is regularly made use of to give increased film density or reduced exposure time. Curves were shown illustrating how the speed of tungstate screens varies with the thickness of the coating for X-rays generated at various kilovoltages and for gamma-rays. Other curves showed how the speed factor of tungstate screens decreases as the thickness of metal increases—a most unfortunate property. Further increase in speed may be attained by special techniques such as hypersensitization before exposure or chemical intensification of the developed image. Owing to the reciprocity failure of the photographic materials, the exposures when using tungstate screens cannot always be calculated accurately by the inverse square law, and curves were shown from which the appropriate factors could be deduced.

For routine work, the ideal exposure time is about fifteen minutes: these short exposure times are attained by reducing the source-film distances, but a limit is imposed by the degree of definition necessary.

The short wave-length of gamma-rays, which incidentally correspond in penetration to X-rays generated at 200–2,000 kV., renders them highly suitable for the radiography of heavy metals, and Mr. Croxson reported that they have been used effectively in the radiography of tungsten steels, tungsten carbide, stellite and lead alloys in addition to their well-known application in the inspection of ferrous, copper and brass specimens. The low radiographic contrast obtained in gamma-radiographs makes the technique ideal for the inspection of specimens having wide ranges of thickness. Moreover, the effect of scattered radiation is not so serious as when X-rays are used: the chief precaution necessary is to back the cassette with lead about 1 mm. thick to avoid back-scattered radiation reaching the film.

For these reasons, gamma-radiography is very suitable for the detection of hot tears, shrinkage defects, blowholes, sand inclusions and cracks in heavy and often complex castings. Several slides were shown

illustrating the characteristic appearances of these defects as revealed in the gamma-radiographs. The method is of particular value in the critical examination of pilot castings in indicating the soundness of the foundry technique. Since such heavy castings are usually costly, the defective regions are often cut out and afterwards welded. Further radiographic examination will reveal the soundness of the repaired section. Welded repairs of this kind may show cracks in the weld or parent metal at the edge of the weld, and Mr. Croxson pointed out that, since these cracks are tortuous and not necessarily in the same plane as the incident gamma-ray beam, great care must be taken in interpreting the radiograph. If any suspicious shadow is seen, another radiograph should be taken in one or more other directions to ensure that the presence of a crack is either confirmed or refuted. Similarly, gamma-radiography may be used for the examination of all types of welds, and the method has advantages over radiography by X-rays when cylindrical objects are being examined: apart from the fact that the radiographic inspection of welds reveals defects, the knowledge that the method will be applied has the moral effect of making welders even more careful in their work.

In concluding, Mr. Croxson said that his experience of gamma-radiography justifies high confidence in the rapid extension of this specialized inspection technique.

STALIN PRIZES FOR SCIENCE, INVENTIONS AND INDUSTRIAL TECHNOLOGY

THE following have been awarded Stalin Prizes (first class) for outstanding achievements and inventions and for improvements of the technology of industrial production in 1942. First Class prizes carry an award of 200,000 roubles each (150,000 roubles in the "outstanding inventions" section):

Physics and Mathematics: P. A. Alexandrov, for studies in mathematics; P. Kapitza, for research on helium.

Technical Sciences: L. S. Leibenzon, for studies on the theory of elasticity and oil mechanics; M. A. Pavlov, for research in the technology of iron smelting.

Chemical Sciences: A. N. Nesmeyanov, for researches on metallo-organic compounds.

Geology and Geography: F. N. Krassovsky, professor of the Moscow Institute of Engineering, Geology and Cartography; P. I. Stepanov, for geological researches on the Donets Basin, summed up in his work "Geology of the U.S.S.R.".

Biology: P. M. Zhukhovsky, for his work "Botany" and for his discovery of new varieties of wheat and rye and the development from them of hybrid varieties of great economic value; V. A. Engelgardt and M. N. Lubimova, for researches on muscles.

Agriculture: T. L. Lysenko, V. P. Mosolov and a group of scientific workers, for development and introduction of a method of using tops of potato tubers for cultivation.

Medical Sciences: V. N. Shevkunenkoz, lieut.-general of the Medical Service, professor of the Military Medical Academy of the Red Army; A. N. Maxinenkov and A. S. Vishnevsky, professors of the same Academy, for the scientific work "Atlas of the Nervous and Venous System".

Philosophy: G. Alexandrov and B. E. Bykhovsky, M. B. Mitin, P. F. Yugin, O. Trakhtenberg and V. Asmus, for the work "History of Philosophy", in three volumes.

For many years' outstanding work in Science and Technique: M. J. Averback, First Medical Institute; A. A. Baikov, Leningrad Polytechnical Institute; B. E. Vedeneyev, Assistant Commissar for Electric Power Stations; V. I. Vernadsky; S. N. Dzhanashya, member of the Georgian Academy of Sciences; B. D. Grekov, the University of Leningrad; I. I. Meshchaninov, director of the Speech and Thought Institute, Leningrad; V. F. Mitkevich, Leningrad Polytechnical Institute; S. S. Nametkin, director of the Institute of Combustible Minerals; A. E. Forai Koshits, "Lensoviet" Leningrad Chemico-Technological Institute; N. P. Chizhevsky, K. I. Shenfer.

For outstanding Inventions and Improvements of Production Methods: N. Blokhin, chief engineer of the Central Board for Special Steels; A. Sheremetyev, director of the Board, and a group of engineers of various works and scientific institutes, for the elaboration and introduction into industry of a new technological process of steel smelting for war industry. V. Grabin, lieut.-general of Engineering Troops; Ivanov, lieut.-general of the Artillery Engineering Service, and the assistants of the chief constructor of the Central Artillery Designing Bureau; P. Nazarov and D. Sheffer and others, for designing new types of ordnance. A. Derkach, engineer of Works No. 695, and a group of engineers of Scientific Research Institute No. 20, for designing new types of radio equipment. Z. Yermolyeva, director of the Department of Biochemical Bacteriology, All-Union Institute of Experimental Medicine, and L. Jakobson, director of a laboratory of the Institute, for the development of a new method of early diagnosis and phagocytic-prophylaxis of contagious diseases. S. Ilyushin, aircraft designer, for modifications and improvements in design of warplanes. Y. Kozhevnik, head of the central board for production of steel tubing; J. Ossadchy, director of Works No. 703, and a group of engineers for improvement of the technology of production of mortar barrels and ammunition parts. V. Kotelnikov, head of a group of engineers of the Central Research Institute of Communications, for designing new communications equipment. J. Kotin, chief constructor of the Kirov Works; S. Makhonin, chief engineer, L. Troyanov, assistant chief constructor, F. Petrov, chief constructor of Works No. 9; S. Gurenko, chief constructor of Work Nos. 172, for designing a new type of artillery; N. Kuznetsov, major-general of the Artillery Engineering Service: A. Semenov, lieut.-colonel engineer, and a group of military engineers, for designing new types of arms. S. Lavochkin, aircraft designer, for modification and improvement of warplanes; H. Luryo, chief engineer of Ballbearing Works Nos. 4, 3 and 1, for organization of mass production of special bearings; B. Malinin, senior scientist of Central Research Institute No. 45, and a group of the staff of Central Designing Bureau No. 18, for designing a new type of warship; I. Maslennikov, director of the Experimental Research Institute for Metal-Cutting Machine Tools, and a group of the staff of the Bureau for Machine Tool Aggregates of the same Institute, for designing new highly efficient machine tools for war industry; N. Polikarpov, aircraft designer, for designing a new model of warplane. N. Rubtsov, Moscow "Baumann" Machine Building Institute, and a group of engineers and staff members, for improvement in the technology

of ammunition production; P. Sukhon, aircraft designer, for designing a new type of warplane; A. Tupolev, aircraft designer, for the creation of a new type of warplane; A. Charomsky, aircraft engine designer, for a new type of aircraft engine. A group of workers of Works Nos. 231, 659, 389, 702, for designing a new type of naval armament; A. Shevtsov, aircraft engine designer, for designing a new type of aircraft engine; A. Yakovlev, aircraft designer, for modification and improvement of warplanes.

FORTHCOMING EVENTS

Saturday, April 10

ASSOCIATION OF UNIVERSITY PROFESSORS AND LECTURERS OF THE ALLIED COUNTRIES IN GREAT BRITAIN (at the Royal Institution, 21 Albemarle Street, Piccadilly, London, W.1)—Educational Conference. At 10 a.m.—"The Function of a University in a Modern Community"; at 2.30 p.m.—"Methods of Practical Co-operation between Allied Universities in the Future".

Saturday, April 10-Sunday, April 11

INSTITUTE OF PUBLIC ADMINISTRATION (JOINT MEETING WITH THE INSTITUTE OF INDUSTRIAL ADMINISTRATION AND THE METROPOLITAN AREA EDUCATION COMMITTEE OF THE NATIONAL ASSOCIATION OF LOCAL GOVERNMENT OFFICERS) (in the County Hall, Westminster, London, S.E.1).—Conference on "Post-entry Training for Administration—the Need for an Administrative Staff College".

Saturday, April 10

2.30 p.m.—Discussion to be opened by Mr. E. S. Byng.

Sunday, April 11

10.30 a.m.—Discussion to be opened by Prof. Harold J. Laski.

Thursday, April 8-Monday, April 12

BRITISH PSYCHOLOGICAL SOCIETY (in the Debating Hall of the Union Society, Oxford).—Extended General Meeting.

Thursday, April 8

8.30 p.m.—Prof. C. Burt: "British Psychology in War-time" (Presidential Address).

Saturday, April 10

Symposium on "Mental Attitudes in Time of War".

9.30 a.m.—Dr. R. H. Thouless: "Hatred of the Enemy".

10 a.m.—Prof. T. H. Pear: "Psychological Implications of 'Re-educating the Germans'".

10.30 a.m.—Mr. Rayyard West: "What are we to Think?"

Monday, April 12

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8 p.m.—Dr. Raymond Firth: "The Coastal People of Kelantan and Trengganu, Malaya".

Tuesday, April 13—Wednesday, April 14

SOCIETY OF GLASS TECHNOLOGY (at Rimfield, Northumberland Road, Sheffield 10).—Annual General Meeting, and Conference on "Education, Technical Training and Research for Post-War Developments in the Glass Industry".

Wednesday, April 14

ROYAL SOCIETY OF ARTS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 1.45 p.m.—Mr. J. G. Crowther: "Science in Soviet Russia" (Trueman Wood Lecture).

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 2.15 p.m.—Dr. A. H. T. Robb-Smith: "The Classification of Medical Literature and Records"; Mr. C. E. Lee: "Documentation in the Transport Industry".

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at Lincoln's Inn Fields, London, W.C.2), at 4 p.m.—Prof. C. Raymond Greene: "Frost-Bite and Kindred Conditions" (Hunterian Lecture).

Thursday, April 15

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Prof. S. Sugden, F.R.S.: "Magnetochemistry" (Ninth Liversidge Lecture).

INSTITUTION OF NAVAL ARCHITECTS (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Annual General Meeting; at 3 p.m.—Dr. G. D. Bengough, F.R.S., and Mr. V. G. Shepheard: "Fouling and Corrosion of Ships"; at 4.15 p.m.—Mr. R. W. L. Gawn: "Steering Experiments", Part 1.

Friday, April 16

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 3 p.m.—Mr. A. R. Dunton: "The Control, Specialized Testing and Use of some Modern Insulating Materials".

Saturday, April 17

BRITISH RHEOLOGISTS' CLUB (JOINT MEETING WITH THE MANCHESTER AND DISTRICT SECTION OF THE INSTITUTE OF THE RUBBER INDUSTRY) (at the Engineers' Club, Albert Square, Manchester), at 10 a.m.—Discussion on "The Rheology of Rubber and Rubber-like Materials" (Chairman: Mr. W. N. Lister).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DISTRICT OFFICERS, and ASSISTANT DISTRICT OFFICERS, to the Somerset War Agricultural Executive Committee—The Executive Officer, Parklands, Trull Road, Taunton (April 14).

EDUCATIONAL PSYCHOLOGIST—The Secretary-Superintendent, Belfast Hospital for Sick Children, Belfast (April 15).

EDUCATIONAL PSYCHOLOGIST—The Secretary, County Education Offices, Castle Street, Exeter (April 16).

LECTURER IN CIVIL ENGINEERING at the Brighton Technical College—The Education Officer, 54 Old Steine, Brighton 1 (April 16).

PRINCIPAL for the Whitwood Mining and Technical College—Mr. M. G. Swaine, Education Offices, 97 Smawthorne Lane, Castleford, Yorks. (April 17).

TEACHER TO TAKE PRACTICAL GEOMETRY in the Manchester School of Building—The Director of Education, Education Offices, Deansgate, Manchester (April 17).

PSYCHOLOGIST at the Child Guidance Clinic—The Secretary for Education, 6 Lampton Road, Hounslow (April 17).

TECHNICAL ASSISTANT, CHIEFLY FOR CULTIVATION AND CROPPING—The Executive Officer, Holland War Agricultural Executive Committee, 15 Market Place, Boston, Lincs. (April 17).

TEACHER FOR GENERAL SCIENCE, PREFERABLY CHEMISTRY, PHYSICS AND SOME BIOLOGY, at the Southend-on-Sea Municipal College—The Chief Education Officer, Education Office, Warrior Square, Southend-on-Sea (April 21).

HEAD OF THE ELECTRICAL ENGINEERING DEPARTMENT of the Rutherford Technical College—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 1 (April 29).

INSTRUCTOR FOR TRAINING RADIO MECHANICS, WITH GOOD QUALIFICATIONS IN THEORY AND PRACTICE OF RADIO WORK, AND A LECTURER IN MECHANICAL ENGINEERING, at the Rugby College of Technology and Arts—The Organizer of Further Education in Rugby, Rugby (April 30).

LECTURER IN ELECTRICAL ENGINEERING—The Principal and Secretary, Harris Institute, Preston.

ASSISTANT ENGINEER for the Georgetown Sewerage and Water Commissioners, British Guiana—The Secretary, Overseas Manpower Committee (Ref. 352), Ministry of Labour and National Service, Sardinia Street, Kingsway, London, W.C.2.

SPEECH THERAPIST—The Acting Director of Education, Education Offices, Becket Street, Derby.

IRRIGATION ENGINEER for the Irrigation Department, Government of Ceylon—The Secretary, Overseas Manpower Committee (Ref. 775), Ministry of Labour and National Service, Sardinia Street, Kingsway, London, W.C.2.

ASSISTANT ENGINEER for the British Guiana Public Works Department—The Secretary, Overseas Manpower Committee (Ref. 767), Ministry of Labour and National Service, Sardinia Street, Kingsway, London, W.C.2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Trade Unionism: a Short Study Course for Scientific Workers. Prepared by J. Kuczynski and a Study Group of the Central London Branch of the Association of Scientific Workers. Pp. 44. (London: Association of Scientific Workers.) 1s. [232]

Chemistry and the Petroleum Industry. By Dr. A. E. Dunstan. Pp. 48. (London: Institute of Chemistry.) [232]

Hannah Dairy Research Institute. Bulletin No. 8: The Production of Artificially Dried Grass. By Dr. James McNair in association with Dr. Alexander B. Fowler. Pp. 111. (Kirkhill, Ayr: Hannah Dairy Research Institute.) [242]

How to Keep Well in Wartime. By Dr. H. A. Clegg. (Issued for the Ministry of Health by the Ministry of Information.) Pp. 24. (London: H.M. Stationery Office.) 2d. net. [242]

Jamaica Constitution. Despatch from the Secretary of State for the Colonies to the Governor of Jamaica, dated 10th February 1943. (Cmd. 6427.) Pp. 14. (London: H.M. Stationery Office.) 2d. net. [252]